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REPORT  
ON  
GRIMES, BRAZOS, AND ROBERTSON COUNTIES.

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BY  
W. KENNEDY.

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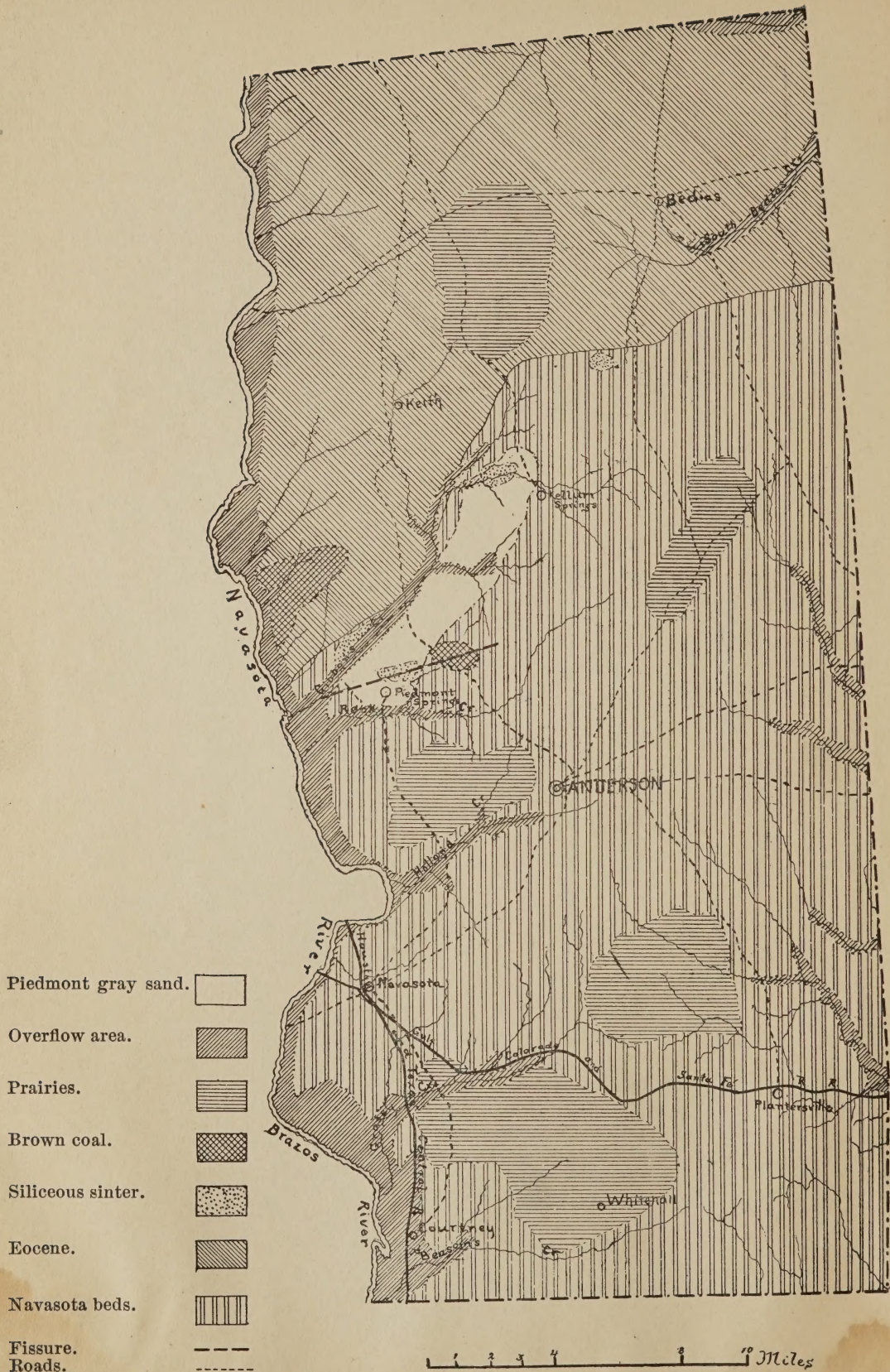
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MAP OF GRIMES COUNTY.



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CHAPTER I.

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GRIMES COUNTY.

GEOGRAPHY AND TOPOGRAPHY.

Grimes forms one of a group of counties lying to the north of and immediately succeeding the great coastal prairie region, forming an intermediate plain between that and the still higher iron ore-capped region of Leon, Houston, Cherokee, and other counties to the north and east. This second prairie, as it might be denominated, lies at a slightly higher elevation, and is somewhat more rolling than the primary or coastal plain. The texture of the soils, general geological structure, and topographical features, as well as the distribution and growth of the arboreal vegetation, are also different.

Although such differences exist between these two great areas, they merge so closely into each other at places that it is often difficult to determine with any degree of exactness where the one ends and the other begins. At other portions of the line of contact the separation is distinctly marked by a series of high, sandy hills, covered more or less by a stratum of coarse, water-worn gravel and pebbles. Such a ridge or dividing line exists along the south side of Grimes county. This ridge begins, toward the south, in Waller county, and rises gradually from 225 feet at Hockley to 245 feet at Hempstead, a distance of 14 miles. At Howth, four miles north of Hempstead, the ridge reaches an elevation of 281 feet, and eight miles further north, near the line between Waller and Grimes counties, it attains its maximum height of over 300 feet above sea level.

Crossing this ridge, the county falls gently toward the north until, in

the region of Navasota, it has fallen to 219–230 feet. From here it again rises gently, at the rate of about 10 to 15 feet per mile, reaching its maximum, so far as the area at present under consideration is concerned, of 370 feet at Iola, in the northern portion of Grimes county. The country north of Iola continues to rise gently toward the northwest, through Brazos and Madison counties, until the Claiborne greensands of the Wheelock prairies are reached, near the Robertson county line.

The portion of this region comprising Grimes county lies south of Madison; Walker and Montgomery counties form the eastern boundary; Waller the south, and the Brazos and Navasota rivers the western lines, embracing an area of about 781 square miles.

The topography is extremely simple. The higher grounds are rolling and interspersed with numerous prairies. Low flat "bottom" lands lie along the rivers and their larger tributaries, and a low range of gray sand-hills covers the southern and southeastern portions.

The following table gives approximately the elevations of some of the principal points in the county:

Waller county line.....	240–300 feet.
Courtney .....	201 feet.
Navasota.....	219 feet.
Yarborough.....	407 feet.
Plantersville .....	323 feet.
Anderson .....	334 feet.
Piedmont Springs.....	279 feet.
Kellum Springs .....	274 feet.
Cawthorn .....	300 feet.
Iola.....	370 feet.
Bedias .....	350 feet.

A narrow, slightly elevated, flat-topped prairie region, beginning on the Wm. Burney headright, about four miles south of Anderson, and extending in a north or north by east direction for nearly 20 miles, forms the divide from which the drainage of the county flows in three directions. The waters of the north and south Bedias creeks, with their tributaries, flow northeast to the Trinity river. Along the west, Gibbons, Rock, Holland, Grassy, and Beason's creeks flow into the Navasota and form a portion of the Brazos river drainage system; and in the southeast, Garrett Lake, Indian, Cedar, and several other smaller creeks flow into and form the headwaters of the San Jacinto river.

#### PRAIRIES.

The generally rolling character of the country changes in places to broad stretches of comparatively level country and the resultant is the inter-spersion through many portions of the county of numerous prairies of varying areas.



These prairies change the topography, and incidentally the soil and native growth, and occur almost altogether within the area underlaid by the rocks belonging to the Navasota group. The most important are Wallace prairie in the southeastern, Grimes, Navasota, and Fuqua prairies in the central and western, Roan prairie in the northeastern, and Anderson prairie in the northwestern portions of the county.

#### GENERAL GEOLOGY.

The geological section shows broad stretches of alluvial or river deposits extending along the rivers and larger creeks throughout the county. The Quaternary deposits are almost exclusively confined to the southeastern portion, where they exist in the form of a yellowish-gray sand, intermixed with and overlaid by a coarse gravel. Thin scattering deposits of this gravel also occur at various places in the northern portion of the county.

Underlying these deposits are a series of beds of calcareous clays and sands and calcareous sandstones, which, for stratigraphic purposes, have for the present been denominated the Navasota beds. They rest unconformably upon a series of gray sandstones and quartzites, associated with extensive deposits of lignitic sands, clays, and small deposits of lignite.

The general dip of all the beds is in accordance with that of the Tertiary and later deposits of Southeast Texas. The course is south 30 degrees east. The dip of the lowermost, or Eocene, division is approximately 50 feet per mile, while the Navasota beds do not exceed 25 to 30 feet at the base, with a general shallowing or decreasing dip toward the upper portion of these deposits.

The general section shows approximately the thickness of the several deposits to be:

- |   |                  |
|---|------------------|
| 1. Recent: River alluvium found along the rivers and large creeks .....   | 25 to 30 feet.   |
| 2. Quaternary: Grayish yellow and brown sands, intermixed with and overlaid by fine and coarse gravel, found in the southeastern section of the county and occurring as small, scattering patches of gravel and pebbles throughout other portions, from a few inches to ..... | 50 feet.         |
| 3. Navasota beds: Blue clays and brownish gray sands, containing great quantities of nodules of carbonate of lime, gray and yellowish white calcareous sandstones and sands.....  | 350 to 400 feet. |
| 4. Eocene gray sandstones and quartzitic sandstones, laminated blue and gray sands and clays, with lignites, occupying the whole of the northern portion of the country, at least..   | 1000 feet.       |

## (1) RECENT.

Along the western side of the county the valleys of the Brazos and Navasota rivers show a continuous belt of recent deposits, having a width of nearly two miles at the southern end, where it is bordered by the Brazos, and narrowing northward along the Navasota. Along the latter this belt varies in width from a quarter of a mile to one mile. Narrow prolongations extend interiorly along the various large creeks tributary to these rivers. These deposits are made up chiefly of brown clays and grayish brown sands, and in structure present the usual laminated conditions found everywhere throughout this portion of the State in areas subject to overflow. Their approximate thickness is about thirty feet.

## (2) QUATERNARY.

The Quaternary deposits occurring in Grimes county consist chiefly of grayish yellow and orange brown sands, intermixed with coarse gravel and small pebbles. In places the sands are altogether wanting, and the deposits are represented by thin beds of coarse gravel and pebbles. The Quaternary gravel and orange brown sands occur in the form of a ridge extending across the county along the line of the Gulf, Colorado and Santa Fe Railway. They form a high ridge, separating the several prairie regions, and in many places the gravels are found overlapping and mixing with the dark limy soils of the prairies. Quaternary sands and gravels also occur about two miles north of Courtney and in the neighborhood of Retreat postoffice, and the sandy portion of them is very heavy in the neighborhood of Yarborough and Stoneham stations, where wells 25 to 30 feet deep do not touch anything else. The same class of deposits occur around Plantersville, and cover the whole of the southeastern portion of the county. Two miles north of Courtney, on the Courtney and Navasota road, the contact between the Quaternary sand and the underlying limy clays belonging to the Navasota beds is seen in the following section:

1. Black soil ..... 1 to 3 feet.
2. Brown sand and pebbles ..... 2 to 4 feet.
3. Blue limy clays containing numerous nodules of carbonate of lime, 2 to 6 feet.

Going northward, the gravels, sometimes accompanied with their associated sands, but often alone, are found in thin, scattering patches. In the neighborhood of Lamb's Spring, on the upper George Mason headright, the higher grounds are covered with gravel associated with a yellow sand, which, however, may be derived from the underlying lignitic deposits. The same thing occurs near Piedmont Springs, on the Moses Evans headright. West of Piedmont, on the James Tuttle headright, the gravel is seen overlying the siliceous sinter deposits as in the following section:



1. Coarse gravel (scattering).
2. Dark gray sand, probably derived from the underlying lignitic.. 1½ feet.
3. Siliceous sinter..... 4 to 5 feet.

At Cawthorn postoffice, on the south side of the Nancy Anderson league, and in the region around that place, the gravel overlies a gray sand, and a section shows:

1. Gray sand and gravel..... 5 feet.
2. Laminated gray lignitic clay..... 15 feet.
3. Light gray sand and sandstone, thinly stratified..... 6 feet.

Near Iola, on Anderson prairie, the section shows:

1. Dark sandy soil..... 1 foot.
2. Thin stratum of gravel and fossil wood..... 6 inches.
3. Light gray clays..... 2 to 4 feet.

The belt of yellow and brown sand occurring in the neighborhood of Plantersville extends northward along the eastern line of the county throughout the greater portion of the piney region. Five miles east of Anderson, in the neighborhood of Apolonia postoffice, and for a distance of over five miles toward the south, wells dug 50 feet deep obtain their water supply in these sands.

#### NAVASOTA BEDS.

These deposits have been tentatively classified as the Navasota beds because of their extensive development in the neighborhood of the town of Navasota. Their general section shows them to be separable into two divisions, comprising:

- a.* Upper division: Blue and yellow, sometimes red, clays, with concretions or nodules of carbonate of lime, and showing occasional strata of gray calcareous sands and thinly bedded, coarse grained, soft calcareous sandstone, and containing more Cretaceous shells throughout the sands, having a thickness of at least..... 75 feet.
- b.* Lower division: Gray and yellow calcareous sandstones, interstratified with coarse yellow sand, containing many worn specimens of Cretaceous shells and beds of a tufaceous yellow colored siliceous limestone, having at least a thickness of..... 350 feet.

#### *a.* UPPER DIVISION.

These beds, as already stated, are made up of blue and yellow, occasionally red, limy clays, strata of gray calcareous sands, and thinly bedded, coarse grained, soft calcareous sandstones.

The prevailing characteristic of the deposits belonging to this division is the peculiar condition of the contained lime. This is usually found in the form of concretions or nodules, varying from two to four inches in diameter, of different degrees of hardness when freshly dug, but easily crumbling to a fine powder when exposed to atmospheric agencies. So

great is their tendency to disintegrate, that in many places they have covered the whole of the exposed surface of the clay bed with a fine white flour-like powder.

The area covered by this division lies mostly in the southern portion of the county, but extends northward along the eastern boundary as far as the latitude of Longstreet, in Montgomery county, and in places extends westward to within six miles of Navasota. Going south, the same deposits are found in wells at Howth Station, in Waller county, and are also exposed in Linn creek, four miles south of Hempstead: The exact position of the beds is somewhat hard to determine, owing to an absence of good sections; but from what can be seen, the inference is drawn that they form a belt of from twelve to twenty miles in width along the southern border of the yellowish gray sandstones of the lower division. Small isolated patches also occupy depressions formed in the underlying division in many portions of the county.

In Grimes county, in the neighborhood of Courtney, the beds belonging to this upper division have a known thickness of fifty feet, as seen in the following section of Capt. Christian's well:

1. Stiff blue clay, with lime nodules..... 50 feet.
2. Gray sandstones, sand, and limestone (?)..... 25 feet.

About two miles north of Courtney, on the Courtney and Navasota public road, a washout shows a section of:

1. Black soil and subsoil..... 1 to 3 feet.
2. Brown sand with pebbles..... 2 to 4 feet.
3. Blue clay, changing to red, and in places white, containing numerous nodules or concretions of lime..... 2 to 6 feet.

The white color of this clay is due to the great quantity of lime present in the deposits. These clays with the contained lime are also found about six miles east of Navasota, lying along the northeastern boundary of Grimes prairie. In this area the beds are colored a light gray, and show the following section:

1. Brown sand..... 3 feet.
2. Grayish sandy clay, with concretions or nodules of lime..... 8 feet.
3. Thin stratum of sandstone..... 6 inches.
4. Bluish gray sand, with nodules of lime and clay..... 2 feet.

Near Longstreet, in Montgomery county, and close to the Grimes county line, the same blue clays and lime concretions appear in various places where cuttings have been made deep enough to go below the surface deposits of brown sand.

The dip of these deposits appears to conform roughly to that of the underlying division, and to have a general S. 30 E. direction, not exceeding from ten to fifteen feet per mile.



*b.* LOWER DIVISION.

The characteristics of the lower division of the Navasota beds are gray and yellow calcareous sandstones, interstratified with coarse yellow sand, containing many worn fragments of cretaceous shells, and beds of tuffaceous yellow colored siliceous limestone.

The sandstones are extremely irregular in structure, passing rapidly from a quartzitic nature to a soft sandstone, and then as quickly to a scarcely consolidated sand. Even where of good texture they are thinly bedded and flaggy. They are rarely continuous over any great extent, but are usually lenticular, alternately changing into coarse sand and large lenses of sandstone.

The region overlaid occupies the whole of the central portion of Grimes, and extends westward across the Brazos river into Washington county. Towards the south the sandstones appear on Beason creek, in the bottom of Captain Christian's well at Courtney, and in many places in the region occupied by Wallace and Grimes prairies. The extent and thickness of these deposits toward the east are not so well known, but from our present knowledge of them they do not appear to extend far across the Grimes county line. At Longstreet, in Montgomery county, the yellow and gray sandstones are replaced by the blue limy clays of the overlying deposits, and in the northern portion of Grimes county the lignitic deposits of the underlying Eocene appear upon the surface as far south as one mile south of Bedia Postoffice on the South Bedia creek.

On the western side of the county the known Eocene lignitic deposits are found as far south as Lamb Springs, on the upper George Mason headright, and for some two or three miles further south. Toward the center of the county the boundary line between these sandstones and the lignitic deposits is very irregular. The sandstones thin out rapidly, and in some places appear only as isolated patches surrounding the higher grounds, while the lower shallow valleys show the streams to be running through the underlying lignitic sands and clays. An illustration of this may be seen in the neighborhood of Cawthorn Postoffice. The postoffice itself and Mr. Siddall's gin house, about a quarter of a mile north, stand upon a 12-foot bed of gray sandstone. Two miles south of the postoffice, on Cat creek, the section shown has a decidedly lignitic appearance, being:

1. Scattering gravel.
2. Brown laminated clay..... 2 feet.
3. Conglomerate..... 2 inches.
4. Brown lignite..... 4 feet.
5. Brownish blue clay to bottom of creek..... 8 feet.

The difference in elevation between these two places is only about 35 feet in favor of Cawthorn.

To the eastward of this about four miles, on the James W. Scott headright, the same thinning out appears, as the whole thickness of the gray sands and sandstones does not exceed forty feet, lignites having been found at that depth in a well on the east side of the headright.

Throughout the area covered by these sandstone beds the soil is usually thin and the sandstones appear upon the surface in many places.

Thus around Navasota and in going north along the Lamb Spring road, a ridge of soft sandstone, with occasional thin beds of clay and beds of sand, trends N. 40 E., and follows the road for nearly four miles to the edge of the bottom lands along Holland creek. This ridge looks toward the west and rises occasionally into bluffs from fifty to seventy-five feet in height. At Holland Creek the bluff shows a section of:

1. Gray sandy surface soil ..... ½ to 1 foot.
2. Gray calcareous sandstone, thinly bedded or flaggy, showing a roughly pitted surface and breaking into irregular lenticular masses, interstratified with coarse gray and yellowish gray sand, and inclosing nodules of white clay ..... 120 feet.

Fuqua prairie is underlaid by these yellow sands and calcareous sandstones, and in numerous places patches appear extending over one or two acres, absolutely devoid of soil and showing the white underlying beds. A small creek near the center of the Fuqua league shows a section of:

1. Dark soil ..... 1 foot.
2. Grayish white sandstone ..... 2 feet.
3. Yellow, changing to white, clay or sandy clay.....

On the Anderson and Navasota public road the whole country, from three miles north of Navasota to Holland creek, is underlaid by the gray sandstones of this group, in no place very far beneath, and in many places forming the surface. North of the creek the region is occupied by the same gray marls which cover the country forming Fuqua prairie.

North of Anderson, Roan prairie presents features somewhat similar. The same yellowish gray sandy material and calcareous sandstones appear in almost every break throughout the region. One mile south of the Roan Prairie postoffice, forty feet of interstratified gray sands and sandstones, showing occasionally much broken impressions of palm leaves, are seen along the side of the hill. The sands and sandstones in this section are thinly stratified and the beds rarely exceed six to eight inches in thickness.

Five miles north of Anderson, on the Kellum Springs road, a cutting shows a section of:

1. Black soil and subsoil.... 3 feet
2. Yellow sand, with limy concretions ..... 2 to 5 feet
3. Gray sandstones ..... 10 feet
4. Yellow sand.....



The contact between these sandstones and the underlying lignitic Eocene deposits is seen in the northeast corner of the county, near Bedia Postoffice. Here the gray sandstones are very much broken and interstratified with gray sandy clay and gray sand. A general section, extending over a length of four miles from near Bedia southward along the Anderson and Bedia road, shows:

1. Gray sand at south end..... 1 to 3 feet.
2. Gray sandstone ..... 1 to 3 feet.
3. Gray sandy clay..... 10 feet.

In this region the sandstones also thin out very rapidly, and with their associated gray sands and sandy clays form only a thin covering overlying the lignitic sands and clays found at Bedia and further north.

From the general slope of the country and the position of the sandstones the dip of these beds appears to be about fifteen feet per mile.

On the northwest corner of the Bigham White league these sandstones appear as quartzites in places, but change rapidly to a soft grayish white sandstone. Two miles north of the Kellum Springs, on the Iola road, a washout close to Little creek shows a section of:

1. Black soil..... 1 foot.
2. Clay ..... 1½ feet.
3. Gray sandstone ..... 1 foot.
4. Blue clay .....

Dip very gentle toward the southeast.

At Kellum Springs the combined section shown in Chalk branch and at the springs gives the following:

1. Brown sand and soil..... 15 feet.
2. Gray sandstones, thinly stratified with partings of gray sands.. 2 to 6 feet.
3. Lignitic sands and clays, dipping southeast 8 degrees in places, but usually not more than 3 to 5 degrees, and showing a series of undulations..... 5 to 12 feet.
4. Very fine chalky white siliceous sinter and white sand..... 2 feet.
5. White sand..... 1 foot.
6. Brown lignitic sandy clay.....

Three miles east of Kellum Springs the gray sandstones again appear in a small creek, and the country from this point to Roan prairie is covered with gray sand, through which the sandstones occasionally appear. Wells dug in this neighborhood pass through this deposit at a depth of over forty feet.

The base of these beds is seen in a creek on the north side of the James Cox league, a little over a mile east of Piedmont Springs, near the old Webb place. The section at this place being:

- |  |               |
|--|---------------|
| 1. Gray sand and gravel. . . . .   | 2 to 10 feet. |
| 2. Broken gray sandstone, stained brown on outside and containing casts or impressions of dicotyledonous leaves. . . . . | 2 feet.       |
| 3. Blue clay, laminated and jointed. . . . .   | 4 to 10 feet. |
| 4. Ferruginous sand. . . . .   | 1 foot.       |
| 5. Sandy clay, white and stained brown. . . . .  | 4 to 6 feet.  |
| 6. Laminated blue sandy clay. . . . .  | 5 feet.       |
| 7. Laminated brown sandy clay. . . . .   | 5 feet.       |
| 8. Irregular deposits of brown sandstone. . . . .  |               |

Broken deposits of quartzitic sandstones occur near the base of these beds on the L. J. F. Mammel headright.

Throughout the central area and along the southern boundary of this group of deposits the sections obtainable are neither so plentiful nor so satisfactory. The general prairie-like nature of the surface of the country, together with the small number of creeks and their generally shallow courses, prevent the obtaining of sections of any depth.

The Rocky creek section shows the sandstones to be prevalent throughout the whole of that creek's course. They are soft and inclined to be conglomeritic, with patches of lime in places, and are frequently covered with a black calcareous soil in which a few nodules of lime occur. In this region they also show a thinning out, as wells from thirty-five to forty feet deep are reported to obtain their water supply from a blue clay.

On Holland creek, five miles northeast of Navasota, a section shows:

- |   |           |
|---|-----------|
| 1. Black soil. . . . .  | 5 feet.   |
| 2. Gray sandstone. . . . .  | 4 inches. |
| 3. Yellow limy clay and thin strata of flaggy sandstone . . . . . | 6 feet.   |

One mile north of Navasota, on the Millican road, the ridge of sandstone already mentioned crosses the road, and the section shown from the top of the ridge to bottom of a small washout is:

- |  |                |
|--|----------------|
| 1. Soft gray sandstone, in thin strata at top and heavy bed below.<br>(The thin flaggy division is separated from the heavy bed by a thin seam of calcareous clay one inch thick.) . . . . . | 2½ feet.       |
| 2. Thin seam of calcareous clay . . . . .  | 2 to 6 inches. |
| 3. Indurated cross-bedded yellow sand. . . . .   | 3 feet.        |

The artesian well bored at the Navasota ice factory shows a section of:

- |  |          |
|--|----------|
| 1. Surface soil, dark gray and limy. . . . .                             | 20 feet. |
| 2. White clay. . . . .   | 97 feet. |
| 3. Soft white rock (sandstone) . . . . .                                 | 10 feet. |
| 4. Sand . . . . .  | 90 feet. |
| 5. Rock (gray sandstone) . . . . .                                       | 4 feet.  |
| 6. Sand . . . . .  | 3 feet.  |
| 7. Rock (gray sandstone), not bored into more than a few inches. . . . . |          |

At mile post No. 166 on the Houston and Texas Central Railway a cutting shows a section of:



1. Gray sandy soil and gravel.....	1/2 foot.
2. Thin ledge of sandstone.....	1 foot.
3. Cross-bedded coarse yellow sand.....	4 feet.
4. Thin ledge of sandstone.....	3 feet.

The dip of these deposits is south of east and at a very low angle.

#### EOCENE.

The northern portion of Grimes county is occupied by a series of thinly stratified beds of sands, clays, and lignites, and occasional thin beds of sandstones, being a part of deposits which cover a wide area, extending from the Sabine river westward to and beyond the Brazos river, and which have hitherto been placed at the base of the Fayette beds. They belong to the beds described by Dr. Penrose\* as "a series of clay and sandy strata, the clay rapidly becoming more and more predominant as we go up the series," and the base of the formation becoming "composed of clays and lignite beds."

These deposits have been hitherto considered as the equivalent of the Grand Gulf series of Hilgard's Mississippi section, and considered as of Miocene age.

They are now assigned to the Eocene, for the following reasons: In 1890 the first invertebrate forms observed by the present Survey in the Fayette beds were found by Mr. E. T. Dumble in the sands immediately overlying these clays in Lee county. During the course of the work of the Survey of 1891 a number of fossils were found in Polk county near the top of the gray sands and sandstones in undisturbed deposits, also directly overlying these beds,† and again during the present year's field work, Mr. J. A. Singley found fossils in the laminated lignitic sands and clays on the Yegua river, at Bluff crossing, in Lee county.

During the course of the present season's work in Brazos county, fossils have again been discovered in the gray sandstones directly overlying and in contact with these beds. All these fossils have been studied recently by Mr. Gilbert D. Harris, the Tertiary palæontologist of the Survey, and assigned by him to the Eocene, he having found among them such typical fossils as *Cardita planicosta*, Sow., *Calyptrophorus velatus*, Con., and others: These belong to the Claiborne division of the Eocene, and their occurrence in the laminated lignitic sands and clays, and in the gray sandstones, necessarily place these deposits in that division, together with the underlying beds of lignites, sands and clays, and the thinly laminated blue and brown gypseous clays and sands lying between the fossiliferous greensand marls of the Moseley Ferry, Wheelock, and Cook mountain sections.

\* Penrose, First Annual Report Geological Survey of Texas, 1889, p. 47.

† Kennedy, Third Annual Report, Geological Survey of Texas, p. 115.

The connection between these gray fossiliferous sandstones and the fossiliferous greensand beds of previously known Claiborne age will be seen in the following section:

1. Gray sand and sandstone, containing *Cardita planicosta*, *Calyp-trophorus velatus*, etc ..... 65 feet.
2. Thinly stratified and laminated gray sands, clays, and lignites, with *Cardita planicosta* and other Eocene fossils..... 1000 feet.
3. Dark blue and brown laminated clays and sands, containing crystals of gypsum..... 50 feet.
4. Brown, yellow, and green sands, containing Claiborne fossils, *Cardita planicosta*, Lamark, *Conus sanridens*, Conrad, *Spirorbis leptostoma*, Swains, *Plicatula filamentosa*, Conrad, *Cythærea sp.*, and others..... 800 feet.

Of these No. 1 and No. 2 occur in Grimes and Brazos counties. The fossiliferous sandstones have not been seen in the former, but occur in Brazos county, a few miles west of the Navasota river. The only representatives of the gray sandstones in Grimes is a small series lying immediately under the the calcareous sands and sandstones of the Navasota beds. The gypseous clays and sands of No. 3 occur in the form of a narrow strip about fifteen miles north, along the northern boundary of Brazos county, where they directly overlies the fossiliferous greensands of No. 4, as seen in the Cedar creek section near Wheelock, in Robertson county, and in Brazos county, near Benchley, as well as Moseley Ferry, in Burleson county.

In the report on the Brown Coal and Lignite of Texas the Eocene divisions of the State, as recognized by the Survey, are divided into four great divisions\* as shown in the following table:

	Division.	Position in section.	Character of beds as shown in Grimes county.
	Fayette division.....	No. 1 of above section	Detached beds of small extent.
	Yegua division.....	Nos. 2 and 3 of above section.	Gray sands, clays, lignites.
Eocene.	Timber Belt division { Marine Lignite	No. 4 of above section	Not found.
		Not represented in above section.	Not found.
	Basal division.....	Not represented in above section.	Not found.

The most typical division of these phases of the Eocene developed in Grimes county is the Yegua division No. 2 of the above section, and consists almost altogether of dark gray clays and gray sands, with occasional deposits of lignite. These beds have a known thickness of 1000 feet.

\* Report on Brown Coal and Lignite of Texas, p. 124.



The record of a well bored at Lamb Springs, on the George Mason headright, near the southern boundary of the lignitic area in Grimes county, while probably not quite as specific as might have been desired, nevertheless shows that the lignitic strata had not been completely pierced at the end of the boring, as lignite was found at a depth of 939 feet, and that the next sixty feet of the well ran through "rock and clays." The water contained was strongly saline. This great thickness is corroborated by the records of the boring of a well at the Agricultural and Mechanical College, near Bryan, in Brazos county. In this well over 900 feet of gray sands and clays were passed through before fossiliferous deposits were reached.

The southern boundary of these deposits in Grimes county is extremely sinuous, and, owing to the overlying materials, very difficult to ascertain with any degree of accuracy. Beginning on the east side of the county, the line begins on the Wesley Fisher headright, near the southeast corner of the Evan Corner league, and extends in a slightly south of west course as far as the Gwyn Morrison headright, and thence in a generally south-westerly direction to Gibbon's creek, where the creek crosses the south line of the Philip Goodbread league. Here the line changes a little more westerly in its course to the Navasota river.

The country occupied by these deposits is generally level and covered by prairie-like areas and extensive post oak flats. The sections obtainable are few and generally shallow. Owing to the objectionable quality of the water found in these sands very few wells have been dug, and any data received from the well diggers are at best unreliable.

The few sections obtained in this region show the structure of these deposits to be chiefly sands and clays, with thin seams of lignitic matter and small deposits of an earthy brown lignite.

A section on the Iola and Bedia public road, where it crosses the South Bedia creek, shows:

1. Gray sandy soil ..... 1 foot.
2. Gray sand ..... 2 feet.
3. Gray laminated sandy clay, stained brown on outside, with lignitic streaks forming the parting ..... 4 feet.

One mile south of Iola, in the bank of a small creek running through Anderson prairie, the following section is seen:

1. Dark gray sandy soil ..... 2 feet.
2. Light gray sandy clay, dipping nearly east ..... 1 inch to 1 foot.
3. Dark gray, changing to a pale brown, sandy clay.....

Between Bedia and Iola the country is flat and prairie-like, interspersed with small motts or clumps of timber, and very generally covered with dark gray sandy soil containing numerous fragments of silicified wood. Near Bedia there are several small outcrops of brown clay and a soft, earthy

brown coal, which form the surface materials over small areas. The soft, earthy brown coal also occurs in the neighborhood of Cawthorn Postoffice, where it appears on the surface, and in the banks of several small creeks. A section on Cat creek shows the following:

1. Gravel .....	Scattering.
2. Brown laminated clay .....	2 feet.
3. Conglomerate .....	2 inches.
4. Earthy brown coal.....	4 feet.
5. Brownish blue clay to bottom of creek .....	8 feet.

About a mile north of Kellum Springs a creek crossing the Anderson and Iola public road shows a section of:

1. Brownish gray sandy soil.....	1 foot.
2. Brown clay with lignitic material.....	4 feet.
3. Earthy brown coal.....	1 foot.
4. Thin seams of white clay.....	4 inches.
5. Brown jointed clay.....	3 feet.

On the west labor of the A. A. Boatwright survey a section shown in the banks of Tanyard branch is as follows:

1. Surface soil, gray sand .....	1 foot.
2. Gray sandy clay .....	3 feet.
3. Gray clay.....	1 foot.
4. Earthy brown coal.....	3 feet.
5. Brown coal.....	4 feet.

In going up the creek the section changes slightly, and about a mile distant the bank shows:

1. Surface gray sand.....	1 foot.
2. Yellow sand .....	1½ feet.
3. Thinly laminated brown sandy clay .....	2 to 6 feet.
4. Earthy brown coal .....	1½ feet.
5. Brown coal, very sandy.....	4 feet.

In this area the country is very level and covered with a grayish brown sand containing great quantities of silicified wood, in many instances showing its structure. Some of these blocks are very large, and trunks of trees measuring over twenty feet in length and from two to three feet in diameter are of frequent occurrence.

The presence of this class of fossil wood, showing in its sober gray and brown tints the texture and general formation of the tree, is the more interesting from the fact that only two miles southwest of this place the the brownish gray sand had given place to light gray sands and white clays, the contained woods of which are beautifully opalized in white, amber, yellow, and brown colors, some of which show in their glassy structure the original texture of the wood, but in many this texture has been altogether destroyed.



Going westward, from Iola to the Navasota river, the country is rolling and covered with a grayish brown to light gray sand, containing great quantities of silicified wood. Small seams of lignite occur in Bull creek, about two miles southwest of Iola, but these are very irregular and very thin.

In no place throughout the wide area occupied by these deposits in this portion of the State has the dip of these beds been satisfactorily observed. In many places they show excessively high dips, and again, within a few miles, the dips have changed to correspondingly low angles, and frequently reverse or northwesterly dips occur for short distances. A measured section at Moseley ferry, on the Brazos, gives the underlying fossiliferous greensands a dip of seventy-five feet to the mile, and the same beds on Cedar creek, near Wheelock, have a closely corresponding slope. The gray calcareous sands and sandstones of the Navasota group do not dip more than fifteen to twenty feet per mile. These laminated sands and clays conform to neither of these groups in so far as seventy-five feet is altogether too high, while the maximum twenty feet of the overlying deposits is as much too low. From the records of the different borings obtainable a dip between forty and fifty feet per mile is estimated as being approximately correct.

#### PIEDMONT SPRINGS AREA.

During the closing period of the Eocene, or early in the time of the deposition of the newer gray sandstones, considerable changes took place throughout Texas, which resulted in the deposition of an irregular belt of light gray clays and sands, and in places pure white clays associated with beds and irregular deposits of a white siliceous sinter. Deposits of this period occur in Polk county near Corrigan, and on Chalk branch in the northern portion of Walker county, and in other localities west of the Brazos.\*

In Grimes county these deposits are best developed in the neighborhood of Piedmont Springs. Small outcrops of sinter occur at Kellum Springs and on Mr. S. Smith's land, about two miles east of Union Hill. In the Piedmont Springs area the deposits consist of light gray sands, with great quantities of beautifully opalized wood, sandy clays, white thinly laminated fine-grained clay, and extensive irregularly shaped deposits of siliceous sinter. A section close to the springs shows:

- |   |         |
|---|---------|
| 1. Light gray sand.....                       | 5 feet. |
| 2. Light gray or pinkish gray sandy clay..... | 2 feet. |

\* In the second Report of Progress, 1891, p. 61, these beds have been assigned to the Miocene, and the same age is also ascribed to them in the Third Annual Report, 1891, pp. 63 and 117.

On the C. O. Edwards headright, and about a mile northeast of the springs, another section shows:

1. Gray sand ..... 1 foot.
2. Thinly laminated yellow and brown sands ..... 5 feet.
3. Fine-grained laminated white clay ..... 4 feet.

The surface of the country in this region is covered with grayish white or light gray sands, containing bowlders of coarse-grained flaky siliceous sinter and great quantities of opalized wood of different colors. While the greater portion of the pieces of opalized wood are small, many of them measure from four to eight feet in length and from one to three feet in diameter. These large trunks are very easily broken, and break with a glassy fracture, although longitudinal sections of from two to four feet are easily obtained.

Two miles west of the springs, deposits of a very fine-grained siliceous sinter occur upon the southwest corner of the James Tuttle league and on the W. P. Zuber headright. A section on the Tuttle league shows:

1. Coarse gravel ..... Scattering.
2. Dark gray sandy soil .....  $1\frac{1}{2}$  feet.
3. Siliceous sinter ..... 4 to 5 feet.

This deposit of sinter underlies an area of from twenty-five to thirty acres.

On the west side of the same league, and about a mile farther west of this deposit, the bank of a small creek running into Dry branch shows a section of:

1. Gray surface sand with small quantities of pebbles ..... 4 feet.
2. Soft fine-grained sand ..... 10 feet.
3. Broken laminated bluish gray clay ..... 3 feet.
4. Lignite ..... 3 feet.

Southwest of the siliceous sinter deposits of the Tuttle league there is another deposit of the same class of material on the W. P. Zuber headright. The sinter in this area occurs in all the creeks and washouts along the east side of the headright, and is overlaid by a light gray sand and gravel made up of pebbles of quartz and jasper, and underlaid by a gray sand, as seen in the following section:

1. Light gray sand and gravel, the gravel scattering ..... 2 to 5 feet.
2. Siliceous sinter ..... 4 to 5 feet.
3. Gray sand, visible ..... 2 to 6 feet.

Two miles east of Piedmont Springs a cutting on the east side of Sandy creek shows a section of:

1. Gray sand with white opalized wood ..... 3 to 5 feet.
2. Thinly laminated gray sandy clay ..... 2 to 6 feet.

Going northward to Kellum Springs deposits of siliceous sinter occur



on the Wm. Fitzgibbon league, and one mile west of the spring the following section occurs in Chalk branch, a small stream tributary to Gibbon's creek:

1. Gray sand.....	1 foot.
2. Lignitic sands and clays.....	5 to 12 feet.
3. Siliceous sinter.....	2 feet.
4. White sand.....	1 foot.
5. Brown lignitic sandy clay.....	

In this region the sinter lies in thin strata or seams between deposits of a coarse white sand, which rests upon a laminated brown sand. The section shown for nearly a mile southward along the creek is a succession of lignitic sands and clays, alternately dipping southeast and northwest. These lignitic deposits overlie the siliceous deposits.

This siliceous sinter, which is locally known as chalk, is reported as occurring in small quantities at other places in this region and in the area between Piedmont and Kellum Springs.

Five miles northeast of Kellum Springs, on a Mr. S. Smith's land, near Union Hill church, there is an isolated deposit of siliceous sinter covering an area of nearly ten acres and having a thickness of over twenty feet. The greater portion of this deposit is covered by a dark gray sandy soil, and gray sands form the prevailing characteristic of the surface of the whole of the surrounding country.

Nowhere throughout the area occupied by these beds can the thickness of the deposits belonging to the Piedmont Springs group exceed thirty feet. On the northeastern border the gray sands and sinters either rest upon or are interstratified with the lignitic deposits; and toward the southwest, in the neighborhood of Piedmont, where they attain their greatest thickness, wells dug to a depth of thirty feet pass completely through these beds and enter blue clays containing thin seams of an earthy brown coal.

The siliceous sinter found in these deposits is a very fine-grained, soft, pulverulent, snow-white mass, amorphous in places and showing lines of stratification in others. It has a specific gravity of 2. Under the microscope the grains are small, rounded, and angular, generally flattened and scaly, and all translucent, some of them being perfectly transparent. Many of the scales are striated and marked in such a manner as to resemble thin sections of the opalized wood.

Throughout the region another grade of sinter is also found. This material usually occurs in the form of concretions, many of which are of large size. In texture it is coarse-grained, and has an appearance very much resembling some blast furnace slags.

The origin of these sinters is not yet known. The amorphous condition of the silica and the small proportions of lime and alkalies found in them, as well as the excessive proportions of the alkalies, potash 2.70

per cent and soda 4.93 per cent, and the considerable proportion of lime, 2.34 per cent, found in the associated clays,\* and the presence of sulphureted hydrogen in the springs now flowing throughout the area in which these sinters occur, appear to indicate the origin to be from springs of moderately warm alkaline waters in active operation at the close of the Eocene or early in the stage of the deposition of the Navasota beds, but which are now extinct.

These springs probably continued in operation during the earlier portion of the Navasota times, and the stratified and assorted condition of the deposits themselves may be the result of leaching and rearranging by water during the period of the deposition of the clays of the upper Navasota beds. The causes of these deposits are long since destroyed. In none of the places yet visited do any springs carrying large percentages of silica now exist. The springs in the Grimes county area are all strongly sulphurous and have a considerable flow. These springs, of which the most important are Kellum, Piedmont, and Shanghai, are slightly thermal, and those at Piedmont and Kellum are depositing thin hair-like masses of pale yellow sulphur. All of them give off considerable quantities of sulphureted hydrogen.

In connection with the sinter deposits, a fracture of the strata, or fissure from ten inches to a foot in width, extends across the region in a slightly north of east direction. The actual depth of this fissure, or how far it affects the underlying deposits, can not be ascertained, as through the whole of its length, a distance of several miles, it is nearly filled with soil and leaves of recent origin. This fissure was traced over a distance of three miles, when it became obliterated; but Mr. G. A. Allen, a reliable observer, states that about twenty years ago it could be traced for over ten miles, and at many places it showed a depth of over seven and even eight feet. The fissure does not appear to be affected by the material through which it passes, as at one part of its course it crosses a small bed of sandstone, in which the fracture appears as clearly as in the sands and clays found at other places along its course. From this fact it would appear that the fracture took place after the deposition and consolidation of the sandstones, and that the disturbing cause belonged to a post Eocene time.

Whether this fracture had any appreciable effect upon the dip of the deposits could not be ascertained. No exposures in which any reliable measurements can be obtained occur in the vicinity of the fissure, nor in the area occupied by the sinters, and as they lie along or close to the division between the underlying Eocene and overlying newer deposits, between which the dips vary greatly, measurements made at wide distances apart would afford no clue to the matter.

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\* See analyses of clay on page 31.



## ECONOMIC GEOLOGY.

## SOILS.

The soils of Grimes county, with the exception of the soils of the bottom lands, may be characterized as nearly all fit for cultivation, although generally poor. Some portions of the prairies, though usually covered with a thin or scanty vegetation, do not have a sufficient depth of soil for farming purposes, and at other places the gray sandstone formations have no soil at all. The areas, however, in which the rock is exposed are of only a limited extent. Those in which the soil is thin are greater, but still form a very small portion of the county and are generally occupied as pasture land. The soils belong chiefly to the two grades—alluvial, or sedimentary, and residual, or sedentary. The alluvial, or sedimentary, are those which have been deposited in and from flowing water, and include all bottom and second bottom valley soils. The residual soils are those which result from the quiet action of the changes of temperature, etc., and are due to the disintegration of the underlying deposits, and consequently have not been removed from their original site, and partake largely of the nature and constitution of the underlying beds.

## ALLUVIAL SOIL.

These soils occur only in the valleys of the Brazos and Navasota rivers, and form a belt of low, flat country, from one to three miles in width, extending through the entire length of that portion of the country adjacent to these rivers. Some of the larger streams, such as Beason's, Holland, and Gibbon's creeks, have wide deltas or bottoms at their mouths, often extending for several miles interiorly along their course. These soils cover nearly one-fifth of the county.

Much of this area is subject to periodic overflows from the two rivers, and a very small part of it is under cultivation. The greater portion is covered with a heavy growth of timber.

These alluvial soils are mostly a stiff clay, laminated in places, and portions of them have a considerable admixture of sand. They are dark brown in color, and from two to six feet or more in depth. Where in cultivation they are the most productive soils in the county. The chief productions are cotton and corn.

Analyses show them to be rich in lime, phosphoric acid, and organic matter, and although the proportions of potash are slightly below the normal, may be considered as of more than average fertility.

Analysis of soil and subsoil of Brazos river bottom, Grimes county:\*

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\* Analysis by P. S. Tilson.

	Soil.	Subsoil.
Silica { Soluble.....	.38	.36
{ Insoluble .....	86.02	81.70
Alumina .....	.69	1.74
Iron.....	1.64	1.92
Phosphoric acid.....	.18	.19
Lime.....	4.14	4.89
Magnesia.....	trace	.29
Potash, soluble in water.....	.11	.14
Soda.. { Soluble in water.....	.02	.28
{ Insoluble in water.....	.21	.22
Sulphuric acid.....	1.44	.34
Chlorine .....	.11	.08
Carbonic acid.....	1.60	3.30
Organic matter.....	2.91	4.74
	<hr/> 99.45	<hr/> 100.19

The cultivation of these soils has a tendency to increase their fertility, by the breaking up of the stiff clay which forms their principal constituent, and the mixing of the clay with the brown sand associated with it in such a manner as to form a clayey loam.

#### RESIDUAL SOILS.

This class of soils occupy the whole of the uplands and nearly one-fifth of the entire county. In texture and characteristics they change in conformity with the change of the underlying beds, from which fact they may be graded into four different classes: 1. The grayish brown and light colored calcareous soils, found resting upon the great stretch of limy beds belonging to the Navasota group. 2. The gray upland sandy soil, overlaying the lignitic formations of the northern part of the county. 3. The black calcareous soils, belonging to the prairie regions. 4. The light gray sandy soil, belonging to the Piedmont series.

1. THE GRAYISH BROWN AND DARK COLORED CALCAREOUS SOILS.—These soils are found resting everywhere upon the Navasota beds in the central and southern portions of the county. They lie in narrow belts and in broad stretches, between and around the black calcareous prairies. They are generally fine sand, of a dark grayish brown color, intermixed in many places with a dark brownish colored clay, varying in depth from a few inches to two or three feet, and underlaid by yellow and brown clay and sandy clay and sand, and, where shallow, by heavy beds of gray sandstone from one to twenty feet in thickness. These soils are easily cultivated at any season, and are generally early, warm, and well drained, and when new produce well, but in a few years rapidly deteriorate. Only a small portion are under cultivation. They are usually associated with the black prairies and used for grazing purposes.

2. GRAY UPLAND SANDY SOILS.—These soils occupy the whole of the



northern portion of the county, and overlie the dark gray sands and clays of the Eocene lignitic, from which they are derived. They vary in thickness from one to one and a half feet, and are composed of a fine-grained sandy loam, with a considerable excess of sand of a dark grayish color and easily leaching to a pale yellowish gray. The subsoil is usually a brown or dark brown sandy clay, with occasional deposits of lignitic clay, and in places small scattering patches of gravel. The soil itself is frequently intermixed with gravel and small pebbles, particularly in the western part of the area.

These soils are warm and early, easily cultivated at any season of the year. They rapidly deteriorate under prolonged cultivation, and in five years are said to lose about one-half of their productive power. Cotton raised on these soils, after several years continuous cultivation, is said to lose considerable of its value by the shortening of its staple.

An analysis of these soils by Dr. W. H. Melville shows them to have the following composition:

	Soil.	Subsoil.
Insoluble in hydrochloric acid.....	93.70	71.75
Soluble silica.....	2.14	12.11
Phosphoric acid.....	.011	.008
Lime.....	.18	.49
Carbonic acid.....	.13	.09
Potash.....	.008	.062
Soda.....	.144	.24
Magnesia.....	.08	.46
Ferric oxide.....	.49	1.90
Manganese.....	.09	.06
Alumina.....	.90	6.46
Sulphuric acid.....	trace	trace
Humus.....	.75	.56
Water.....	1.28	5.46
	<hr/>	<hr/>
	99.903	99.65
Capacity for water.....	36.4	65.9

A mechanical analysis of the same soil and subsoil shows the physical condition to be:

	Soil—		Subsoil—	
	Fixed.	Volatile.	Fixed.	Volatile.
Fine soil.....	3.66	.96	20.16	2.92
Fine sand.....	20.25	.64	13.95	.90
Medium sand.....	62.61	.31	53.86	1.91
Coarse sand.....	10.72	.22	6.16	.14
Stones and sticks.....	.55	.08	.....	.....
	<hr/>	<hr/>	<hr/>	<hr/>
	97.79	2.21	94.13	5.87
	} 100		} 100	

These soils frequently form extensive prairie regions, such as Jones prairie, near Iola, and others. The quality and texture of the prairie soils differ but slightly from those of the timbered land. Throughout the prairie regions the soil, although classified as sandy, contains a greater proportion of clay, and the subsoil is of a more impermeable nature.

3. BLACK CALCAREOUS SOILS.—These soils belong altogether to the prairies of the higher lands in the central and southern portions of the county, and are found overlying the gray calcareous sands and sandstones of the Navasota beds. They are best developed on the Wallace and Grimes prairies, where they occur from two to four feet in depth. They also occur on Roan and Fuqua prairies. The soil is of a black, tenaceous, adhesive loam, varying in thickness from a few inches to four feet. “These prairie soils, unless baked too hard, are easily tilled in dry, but are difficult to till in wet weather. They are early and warm and are well drained.”\* The subsoil is mostly a stiff limy yellow clay in Grimes and Wallace prairies, and a yellow sandy clay in Roan and Fuqua prairies, varying in thickness from two to eight feet or more, and resting directly upon a fine-grained, more or less calcareous, sandstone. This sandstone appears on the surface at many places in all of the prairies, and over extensive areas of Fuqua prairie the soil has been denuded, showing the yellow subsoil. The characteristic structure of these prairies may be summed up shortly.

*Wallace Prairie.*—Lies in the southwestern portion of Grimes county, and covers an area of nearly forty-five square miles, comprising the greater portion of the Caleb Wallace, John Whitesides, Samuel Fuller, Tandy Walker, James Wallace, and Jared E. Groce leagues. The surface is slightly rolling and covered with a dark calcareous soil, from one and a half to two feet thick, overlying a yellowish clayey calcareous subsoil, ranging from two to eight feet in thickness, and both resting upon a fine-grained calcareous sandstone, which appears on the surface in many places. Exposures of this character may be seen at White Hall and along the northern end of the prairie. On the Tandy Walker league the sandstone forms a ridge from fifty to seventy-five feet above the level of Grassy creek.

*Grimes Prairie.*—Comprises a small area of about sixteen square miles, lying northeast of and separated from Wallace prairie by a sandy ridge which is traversed by the line of the Gulf, Colorado and Santa Fe Railway. This prairie includes the whole of the Margaret McIntyre and the greater portion of the Jesse Grimes and Franklin Greenwood leagues. In general features it resembles Wallace prairie. The gray calcareous sandstone appears upon the surface in many localities, and the soil is black,

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\* Loughridge, Cotton Production, 10th Census, Vol. V, pp. 745-746.



calcareous, and about two feet deep. Water is usually obtained anywhere on the prairie at a depth of twenty to twenty-five feet.

*Navasota Prairie.*—Embraces the region lying contiguous to the town of Navasota, and covers an area approximating fifteen square miles. The greater portion is covered by a dark brown, changing to black, calcareous soil, from one to three feet in depth. Other portions are covered by a dark gray calcareous sandy soil, closely resembling the underlying gray sands and sandstones. This class of soils is generally thin, and in places the gray underlying beds appear through the soils and form the surface of considerable areas.

*Fuqua Prairie.*—Six miles north of Navasota, between Holland creek on the south and Rock creek on the north, Fuqua prairie occupies an area of nearly nine square miles, comprising portions of the Ephraim Fuqua, William Holland, and Hannah Cornaugh leagues, and a small portion of the northeastern part of the Robert Ray headright. This prairie is probably the most unproductive of all the prairies in Grimes county. In general structure it resembles both Wallace and Grimes, and closely approaches Roan prairie. The gray sandstone appears forming the surface over a considerable portion. The soil is black and calcareous, but has been removed over a considerable area, exposing extensive tracts of the grayish yellow siliceous subsoil.

This prairie lies at a much higher elevation than any of the others, and, due to its surroundings, is much more exposed to the eroding influences of rain and other atmospheric agencies.

*Roan Prairie.*—This is a narrow strip of prairie land, lying in a general northeast and southwest direction from the southeast corner of the Joshua Hedley league, through the Anthony D. Kennard, John Harris, and William McCaffin leagues, and ending on the south side of the Cyrus Campbell league. In length, the prairie does not exceed six miles, and its greatest width is nowhere over a mile and a half. The total area is not more than ten square miles. The surface is covered with a black calcareous soil underlaid by a yellowish gray sandy limestone. In places the gray sandstone and limy concretions occur in the roads, and about a mile south of the Roan Prairie postoffice occasional pieces of plant remains, mostly leaves of a small palm or palmetto, were found in them.

Wells dug throughout the prairie supply water strongly impregnated with lime.

These prairies—Wallace, Grimes, Navasota, Fuqua, and Roan—all belong to the same age, and in structure closely approach each other. The succession of black soil, yellow subsoil, and gray sandstones is alike in each, and the general conditions surrounding them are such that the whole may be ascribed to one origin. There is no natural tree growth,

but trees grow very well where planted, and bois d'arc hedges are quite common.

*Anderson Prairie.*—In the northwestern portion of the county a large area, comprising the greater portions of the Nancy Anderson, J. W. Stoddard, Beverly Tucker, J. W. Scott, and S. R. Marshal headrights, is known as the Anderson prairie. While the greater part of this might be classified as prairie land, the growth of small post oak and black jack trees have so encroached upon the rest of the area as to destroy its every claim to be so considered. In point of fact, small knots and clumps of trees are springing up everywhere so fast that it will require only a few years to cover the whole. Anderson prairie comprises an area of more than twenty square miles.

The prairies are not much in cultivation. They are used mostly as hay and pasture lands.

4. GRAY SANDS OF THE PIEDMONT SPRINGS AREA.—These sands form a poor soil, supporting a scanty vegetation, and are not much under cultivation.

Along the eastern border of the county, through the pine regions, there occurs a variety of soils partaking of the nature of the first three classes before enumerated, but under such conditions that it would be difficult to differentiate them. They are generally known as the piney woods lands, and are made up of a mixture of gray and brown sands and blue and grayish blue calcareous clays. Small patches of stiff tenacious black calcareous clay occur scattered through the area, but most of it is covered by a dark brown sandy loam, of a more or less calcareous nature.

These piney lands are generally considered the best upland soils in the county.

#### BUILDING STONES.

The building stones of Grimes county are wholly of gray sandstones, and belong chiefly to beds of the Fayette division of the Eocene and the lower division of the Navasota beds of the post Eocene age. Possibly a few of the thin shaly sandstones found intermixed with the blue limy clay and calcareous sands of the later Navasota beds may be found suitable for building purposes, but their coarse texture and general want of coherence will militate against any extensive use of them.

Apart from their difference in age, the building stones differ considerably from each other in their general texture and adaptability, and may be grouped into three classes: 1st. The hard, semi-quartzitic and close-grained sandstones of the Eocene. 2d. The soft, thinly bedded, calcareous sandstones belonging to the lower Navasota beds. 3d. The granular, coarse, semi-consolidated sand or soft sandstones, interstratified with the

coarse-grained gray calcareous sands and calcareous clays of the upper beds of the same group.

1. **HARD, SEMI-QUARTZITIC AND CLOSE-GRAINED SANDSTONES.**—These occur only in the north central portion of the county, where they appear as a narrow belt, extending from the L. J. F. Mammel headright northeasterly to the northwest corner of the Biggam White headright, and from this latter place thin beds extend north and easterly to within a few miles south of Bedias postoffice, on the D. S. Stone headright. They are best developed on the Biggam White headright, where they are represented by a ledge from fifteen to twenty feet high. The rocks forming this ledge are stratified and lie in strata from six to eighteen inches in thickness, and change from a soft gray colored to a hard gray and brownish gray colored sandstone, with occasional blocks showing the characteristic texture of quartzite. Some of the beds are very much broken and tilted in places, and lie mostly in the shape of large boulders or blocks, many of them measuring from eight to ten feet in length and nearly as many feet in width. On the Mammel headright the same class of rocks occur along the northern edge of the Gibbons creek bottom lands. Here they lie in a very similar condition to that on the Biggam White land, although the blocks are more irregularly formed and much smaller and are of less value as a building material.

Intermediate between these exposures the rocks belonging to this group are white and grayish white, evenly bedded, close-grained sandstones. This class occurs in quantities along the upper division of Rock creek on the John Bowman headright. Another deposit is found in the Francis Holland headright, about a mile south of Anderson, on the Anderson and Navasota public road. These rocks lie close to and appear on the surface in many places. They have been quarried both on Rock creek and in the neighborhood of Anderson, and from the smoothness of their grain and closeness of texture admit of being dressed in a fairly good condition, although somewhat limited as to size. The stone finishings of the new court house at Anderson are from the quarry south of that place.

2. **THE SOFT THINLY BEDDED CALCAREOUS SANDSTONES.**—These sandstones include the beds found in the deposits belonging to the lower division of the Navasota group, and are usually thinly bedded, rarely exceeding six inches in thickness, show a rough surface, and in quarrying break into irregular masses or slabs. Their texture is soft and coarse-grained, in places strongly calcareous, and often inclose small nodules or fragments of white clay. In color they vary from a soft gray to a white or creamy yellow. They are irregularly distributed in the beds, changing frequently from the consolidated sandstone to an unconsolidated mass of grayish yellow sand, and in this condition form a continuously alternating series of lenticular masses of sandstone and sand.



The sections exposed in the several quarries are made up of alternate strata of sand and sandstone.

Exposures of these rocks occur at numerous places throughout the southern central portion of the county and in the neighborhood of Navasota. The exposures seen near this place form a ridge extending from near the Navasota river in a northerly direction, skirting the river bottom to Holland creek, a distance of about four miles. This same ridge then passes up the south side of Holland creek to the crossing of the Navasota and Anderson public road, where the sandstones are exposed over an area of several hundred acres. These rocks also appear on Grimes prairie and near White Hall postoffice and several other points along the northern side of the prairie.

Sandstones in the neighborhood of Navasota belonging to this group have been quarried for building purposes for a great number of years. They are used in Navasota as building material almost exclusively. They are also said to have been used for the manufacture of lime many years ago.

3. UPPER NAVASOTA SANDSTONES. — The soft gray semi-consolidated sandstones of the upper division of the Navasota beds are almost altogether unsuited for building purposes. Fairly good rock may be found occasionally throughout the beds, but the quantities are so small that these sandstones can not be considered as of any economic value.

#### CLAY.

In several portions of Grimes county deposits of clay exist in greater or less quantities, and in qualities ranging from the ordinary brick earths to a grade suitable for the manufacture of the ordinary or even finer grades of earthenware. Some of the limy clays might also, with careful selection and cleaning, be utilized for the manufacture of a fair grade of cement.

Brick clays or earth occur at different portions of the county, but no steady brick making industry is carried on. Near Navasota a yellowish brown earth has been used for brick making purposes at intermittent times for years, and the bricks used in Navasota for building and paving purposes were made in this yard. These bricks are very hard, and of a brown color, more or less spotted with blue iron stains. A good grade of yellowish gray earth for brickmaking occurs in great quantities in the neighborhood of Anderson. By care in selecting the materials, two grades of bricks can be obtained in this neighborhood, distinguishable chiefly by their color, as both, when properly made, are hard and of good texture. In color they range from a creamy white to a yellow in the first grade, and a bright red in the second grade. The new court house at Anderson is built of these bricks, and presents a very pleasing effect,

An extensive deposit of a good clay occurs in the neighborhood of Piedmont Springs. In structure it is thinly stratified and breaks with a sub-conchoidal fracture. Thin streaks or stains of iron occur at places throughout the partings, but in general the clay is milky white. An analysis in the laboratory of the Survey shows:

Silica.....	58.50
Alumina .....	18.39— 76.89
Ferric oxide .....	3.21
Lime.....	2.34
Magnesia.....	1.61
Potash .....	2.70
Soda .....	4.93
Sulphuric acid .....	trace— 14.79
Water and loss .....	8.70— 8.70
	100.38

Specific gravity, 1.5.

The high percentage of the alkalies, iron, lime, and magnesia contained in this clay places it in the anomalous position of midway between the grade of a good pottery clay and a "slip" clay. It might probably, with care, be utilized for certain grades of earthenware. In composition the Piedmont clay closely resembles the "Albany" slip so much used among the pottery manufacturers for glazing purposes, and by careful preparation, with the addition of a small quantity of lime, might be utilized for glazing in the same manner as the kaolite slip clay of Ohio. The analysis of this kaolite is:\*

Silica.....	62.40
Alumina .....	10.42— 72.82
Ferric oxide .....	5.36
Lime.....	9.88
Magnesia .....	4.28
Alkalies.....	.87
Sulphuric acid .....	.65
Phosphoric acid .....	.19— 21.23
Carbonic acid .....	8.05— 8.05
	100.00

Tests are now being made in the laboratory of the Survey with the view of determining the practical value of Piedmont clay. The results of these tests will be published in the report on the clays of the State now in course of preparation.

Throughout the northern portion of the county deposits of clays suitable for the manufacture of coarse earthenware occur in many places. Some of these deposits may prove useful, but most of them are of no practical value, because of their location and small extent.

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\* Geological Survey of Ohio; Economic Geology, vol. V, p. 671.

Throughout the beds belonging to the upper division of the Navasota beds there are considerable deposits of a dense calcareous clay, many of which contain large quantities of carbonate of lime in such intimate connection that possibly, with careful preparation, they may be utilized for the manufacture of a fair grade of cement. Extensive deposits of this grade of clay occur in the neighborhood of Courtney.

An analysis of this clay shows:

Silica .....	40.69
Alumina .....	12.68
Ferric oxide.....	3.90
Lime .....	18.12
Carbonic acid gas and water.....	18.91
Alkalies by difference.....	1.14
Magnesia .....	.92
Manganese .....	trace
Water at 100 degrees C.....	3.64
	100.00

#### ABRASIVE MATERIALS.

The siliceous sinter on the southwest portion of the J. W. Tuttle league and W. P. Zuber headright may, with but slight preparation, be used as an abrasive or polishing material. It has a very fine-grained texture, and appears to be free from coarse sand or grit of any kind, or other deleterious ingredients. It contains about 95 per cent of silica, and is of a pure white color. Considerable quantities have already been mined and sold in Houston.

The extensive deposit found on the farm of Mr. S. Smith, near Union Hill church, and the deposits occurring near Kellum Springs, may also be used for the same purposes.

#### LIGNITE AND BROWN COAL.

No lignites of any commercial value were observed within the area of the county. Thin seams of a brown peaty lignite occur in the neighborhood of Kellum Springs, and stretch across the county in a northeasterly direction as far as Bedias postoffice, near the northeastern corner of the county. A seven foot deposit of lignite also occurs in Tanyard creek, on the Boatright headright, near Piedmont Springs. This is of the brown grade through the upper three feet, mixed with a brown clay, while the lower four feet of black lignite is too much mixed with a black sand to be of any economic value.

In the records of a boring at Lamb Springs, fifteen miles north of Navasota, brown coal has been reported at various depths and of different thicknesses. Roughly the section of this well shows;



1. Lignite, first seam, at 12 feet.....	2 feet.
2. Lignite, second seam, at 34 feet.....	2½ feet.
3. Lignite, third seam, at 38 feet.....	2 feet.
4. Lignite, fourth seam, at 41 feet.....	7 feet.
5. Lignite, fifth seam, at 52 feet.....	10 feet.

Several deposits of brown coal are reported as occurring deeper in the boring, but all accompanied by a heavy flow of water.

A small deposit of brown coal also occurs in the bank of the Navasota near Sulphur Springs.

Every one of these deposits are situated in a region of poor road facilities, and too far from any railway communication, which reason renders these lignites and brown coals of little economic value at present.

#### TIMBER.

The total area of Grimes county is 781 square miles, of which nearly two-thirds, or approximately five hundred square miles, are covered with timber.

Extending along the eastern border of the county, from a little west of Plantersville station, northward to within four miles east of Anderson, and thence in a slightly west of north direction to the vicinity of Kellum Springs, where it turns sharply to the northeast and passes out of the county, is the western limit of the great East Texas pine belt. This pine belongs to the short leaf loblolly class. No long leaf pine occurs in the county. The trees are generally small, and toward the outer edge of the belt scattering.

On the flat gladey land of the central and upper portions of the county the timber growth is almost exclusively post oak, and black jack oak, with some hickory. Elm, ash, pin oak, and cedar, with some pecan and smaller growth, occupy large areas of the bottom and second bottom lands, and a few cottonwood trees are to be found in the bottoms. Trees of this class are, however, of a very limited number.

The milling interest is small, there being, according to the last assessment roll, only one saw mill within the county. A fair average estimate of the quantity of timber would give of pine from five to eight thousand feet of lumber per acre, and from fifteen to twenty cords of wood per acre for all other kinds of timber.

#### WATER SUPPLY.

The drainage of the country is divided into three areas—the northeastern or Trinity river drainage; the southeastern, belonging to the San Jacinto area; and the western or Navasota river drainage, the last being a tributary of the larger Brazos river basin. A slightly elevated ridge

of rolling timbered land, interspersed with prairies, forms the divide between these drainage systems. Few springs occur; and the creeks, with the exception of the larger ones, being dependent upon the rainfall, are dry during a considerable portion of the summer months. The larger creeks, such as the Bedias, Gibbons, Lake, Garrett, Cedar, Beasons, Grassy, and Holland, except in very dry seasons, usually contain small quantities of water through the whole of the year; but storage tanks are very generally resorted to for stock purposes.

There are very few freestone springs, but water, though generally of a very poor quality, can be obtained from wells at a very short distance beneath the surface. Water from the wells dug in the southern division of the county is usually very strongly impregnated with lime, while that supplied by the wells of the northern portion is either a sulphur water or else impregnated with the salts of iron. Good water is usually obtained from wells dug in the gray sands of the Piedmont Springs area, and in some portions of the southeastern part of the county, where the water comes from the overlying sands of the Quaternary.

The rainfall is ample for all the requirements of either cultivation or stock-raising, the annual precipitation being about 43 inches, and nearly equally distributed throughout the year, as follows:

Winter months—December, January, February*.....	10.94 inches.
Spring months—March, April, May .....	14.62 inches.
Summer months—June, July, August .....	7.46 inches.
Fall months—September, October, November.....	10.22 inches.

#### ARTESIAN WATER.

The question of a supply of good water being obtained from artesian wells in any portion of Grimes county, outside of the immediate vicinity of the Brazos river and its bottom lands, may be considered doubtful. In the bottom lands of the Brazos and Navasota rivers good water may possibly be obtained at depths ranging from 220 to 250 feet. Three wells bored at Navasota obtain their supply from a gray sand at a depth of 240 feet. The flow of two of these wells is fairly good, while in the third the water, although coming to the surface, requires pumping to cause any appreciable flow, and the water may be classed as of good quality and suitable for all domestic as well as some classes of manufacturing purposes. In quality and characteristics it resembles that of the wells fur-

\*These figures are deduced from observations made at the four signal stations nearest to and in the same region as Grimes county, viz., Brenham, College Station, Huntsville, and Hearne, as reported in Annual Report of Chief Signal Officer for 1890, pp. 729-730. The average precipitation in this region in 1891, as observed at these stations, was 44.39 inches.—Monthly Weather Review, December, 1891, p. 327.

ther north at Steele's store and other places in Brazos county. The Navasota flow, however, is not so strong as at these localities.

The only artesian well bored in the northern part of the county is at Lamb's Springs, on the northernmost George Mason headright. This well is located in a high sand-covered country, and the whole of its depth is through Eocene deposits. It is 1000 feet deep, and passes through a series of lignitic sands, clays, and lignites for its whole depth. In the boring three streams of water were passed through; the first, at 79 feet, reported as flowing 900 gallons per hour; the second, still larger, at 540 feet; the third, at the bottom of the boring. The present flow is obtained from the 540 foot bed, and comes up in a strong stream, rising about eight feet above the surface. The water is strongly sulphurous and unfit for use.

For the purpose of preserving the flow of the 540 foot stream, and at the same time sinking the well still deeper, in the expectation of finding a stronger flow of water, a smaller tubing was inserted and the boring continued. At 999 feet another flow of artesian water was reached. This last flow is not so strong as the one at 540 feet, and the water obtained is strongly saline and as disagreeable to the taste as "bittern." It is utterly unfit for use.

There are no navigable streams in the county. The Brazos was, at one time, the chief commercial highway for the district, and small steamboats plied between the town of Washington, near the mouth of the Navasota river, and the coast. No traffic of any kind has been carried on by this method for a great number of years, and the river is now impassable for any but the smallest boats.

#### MINERAL SPRINGS.

Towards the lower border of the Eocene lignitic deposit and in the belt of gray sands and sandstones forming the Piedmont Springs area, there are several mineral springs, of which Piedmont, Kellum, and Shanghai Springs are the more important. The Shanghai Springs are, however, very little known, and have never been utilized either as a health or pleasure resort. All these supply sulphur water.

Piedmont Springs are situated on the Moses Evans survey, and were once the center of a considerable floating population, of which nothing now remains but the ruins of an immense hotel. The springs themselves issue from the banks of a small creek, and are three in number—two close together, and the other a short distance down the creek. The water is sulphur, slightly thermal, and not very highly charged with sulphureted hydrogen. The flow is fairly good, and the spring deposits are mostly a pale yellow sulphur.

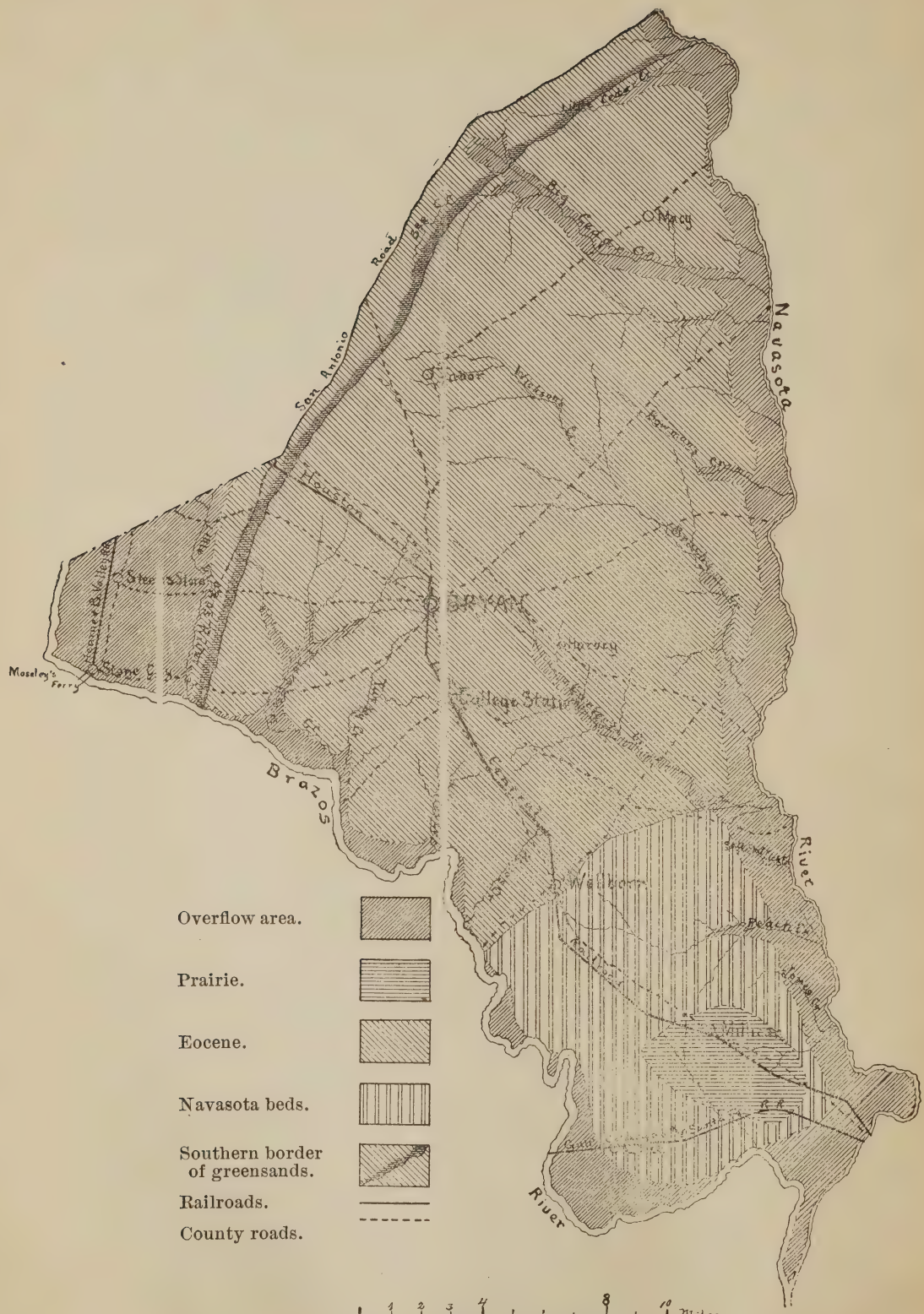
Kellum Springs are situated on the southeast quarter of the William










Fitzgibbon league. The water is also a sulphur, and of a temperature similar to the Piedmont. The flow from the main spring is comparatively strong, and the water is slightly impregnated with sulphureted hydrogen. Kellum Springs were at one time a place of considerable resort for health and pleasure, but have now fallen into disuse. They have still a local reputation of extraordinary curative powers.

The other smaller springs are all sulphur, and some of them so highly charged with sulphureted hydrogen as to give rise to the idea that they rise from and form the vents or outlets of a vast reservoir of gas at no great depth beneath the surface, and which might be profitably utilized. It is scarcely necessary to say that no evidence was found of the existence of such a reservoir, nor of natural gas ( $\text{CH}_4$ ), in this or any other portion of Grimes county.





- Overflow area. 
- Prairie. 
- Eocene. 
- Navasota beds. 
- Southern border of greensands. 
- Railroads. 
- County roads. 

1 2 3 4 8 10 Miles

MAP OF BRAZOS COUNTY,



## CHAPTER II.

### BRAZOS COUNTY.

#### GEOGRAPHY AND TOPOGRAPHY.

Brazos county belongs to the great group of counties comprising Montgomery, Walker, Grimes, and others to the eastward, and Washington and others to the west, forming a great secondary plain or prairie lying to the north of the coastal or primary plain. This county lies in the form of a delta between the Navasota river on the east, and the Brazos river on the west. It is bounded on the north by Robertson county. Its whole area comprises 519 square miles.

The topographic features are simple in the extreme. Bordering the Navasota river on the east, there is a long narrow strip of low lying bottom lands, and the same feature characterizes the region along the Brazos river on the west. In the northwestern corner the whole of that portion lying between the Little Brazos and the Brazos rivers is low lying bottom lands, bordered on the east by a ridge of broken bluffs, rising toward the north into rounded gravel-covered hills having an altitude of 100 to 150 feet above the general level of the bottoms. In the northeastern and northern areas the county presents a continuation of the brown prairies so extensively developed throughout the southern portion of Robertson county. The central and southern portions are rolling, and present the appearance of a great plain rising gently to the north, with extensive tracts of prairie, cut here and there at irregular intervals by long narrow strips of a stunted growth of timber. This timber usually marks the course of the creeks. In the extreme south the land is low, level, and mostly subject to overflow.

The general altitude of the county does not exceed 350 feet above sea level, and the elevations of the principal points are:

Bryan .....	371
Hill three miles north of Bryan .....	375
College Station .....	350
Wellborn .....	323
Millican .....	300
Ella .....	206
Steele's Store .....	253
Stone City (Moseley Ferry) .....	248
Tabor .....	420
Macy .....	430
Hill six miles north of Bryan .....	360

The county is drained by the two rivers, the Brazos and the Navasota, and their tributaries. Along the eastern boundary Little Cedar, Big Cedar, Sandy, Bowman, Brushy (with its tributary creeks, Wickson and Mathis), Carter's, Salt Flat, and Peach creeks flow into the Navasota river. On the west the Little Brazos, Thompson, Turkey, White, and Hope creeks flow into the Brazos river. These creeks have generally wide, and most of them comparatively deep, courses or channels, but during the dry season and summer months are altogether dry, or nearly so. For the greater portion of the year water in these creeks exists only in the form of stagnant pools.

#### GENERAL GEOLOGY.

The geological section of Brazos county shows the alluvial or recent deposits covering many square miles bordering the Brazos and Navasota rivers, and extending for considerable distances along the channels of some of the larger creeks. These deposits range in depth from a few feet in places to 30 feet or more in the immediate vicinity of the rivers. The Quaternary gravel and sands are but sparingly represented, and only throughout the higher portions of the county. In the southern portions the lower divisions of the Navasota beds appear over a small area, and consist only of gray calcareous and non-calcareous sandstones. The upper or calcareous clay division of the Navasota beds, as represented near Courtney, in Grimes county, is altogether wanting, although proof of its former presence and subsequent erosion by the combined action of the two rivers can be easily recognized. In Grimes county, along the eastern side of the Navasota river, a ridge of gray calcareous sandstones, in the form of a series of bluffs, extends from near the river about two miles west of Navasota, in a general northern direction for several miles. On the west side of the Brazos river, in Washington county, there extends a ridge corresponding in general structure and altitude, and having a course as nearly parallel to the Brazos as the Grimes county ridge to the Navasota. These two ridges both present abrupt faces riverward, and opposite each other, and by weathering are receding from both rivers. A great portion of the intervening area is now filled with recent deposits, but remnants of the eroded beds still remain in Barker's prairie, and can also be seen at the bridge across the Brazos river on the Navasota and Washington road, and at Hidalgo Falls.

Immediately underlying the beds belonging to the Navasota beds comes a series of gray sandstones, containing plant impressions in some places, and in other portions *Cardita planicosta*, Lam., and several gasteropods belonging to the deposits of the Claiborne age. These beds appear to mark the southern boundary of the Eocene Tertiary in this part of the State.

Underlying these fossiliferous gray sandstones there appears an extensive series of gray lignitic sands, clays, and lignites, thinly stratified and containing quantities of much broken plant remains and scattered bones of a reptilian fauna. The base of this series of deposits consists of a heavy deposit of gypseous clay and sands, which rest directly upon the fossiliferous Claiborne greensands and marls as represented in the Moseleys Ferry and Cedar creek sections, as well as on Campbell and Elm creeks in the southern portion of Robertson county.

These fossiliferous greensands form a belt having an approximate width of four miles in the northeastern portion, and from four to five miles in the area drained by the Little Brazos river, and constitute the lowest horizon represented in Brazos county.

The general dip of these beds is south 30 degrees east, in conformity with the general course of all the beds in this portion of the State. The lowest fossiliferous greensands have a dip of 75 feet per mile, where measured at Moseley's Ferry on the Brazos river, and the lignitic deposits appear to have a general dip of about 50 feet per mile, but are very irregular. The Navasota beds vary exceedingly, but do not appear anywhere to exceed 20 feet per mile. These last show a gradual shallowing of dip from north to south.

The general section shows the sequence and approximate thickness of the several deposits to be:

- |   |                  |
|---|------------------|
| 1. Recent: River alluvium, found along the rivers and larger creeks .....   | 15 to 30 feet.   |
| 2. Quaternary: Grayish yellow and brown sands, intermixed with and overlaid by coarse gravels and pebbles of quartz, jasper, and fossil wood .....  | 25 feet.         |
| 3. Navasota beds: Southern portion of the county, gray calcareous sands and sandstones, exposed chiefly in Barker's prairie.....  | 150 feet.        |
| 4. Eocene:  |                  |
| (1) Gray sands and fossiliferous sandstones, forming a narrow belt across the southern portion of the county near Wellborn.....   | 65 to 90 feet.   |
| (2) Laminated and lignitic gray and blue sands, with broken plant remains and reptilian bones, occupying the greater portion of the county .....  | 900 feet.        |
| (3) Gypseous clay, seen near Benchley and along the northern border of the lignitic sands.....  | 30 feet.         |
| (4) Fossiliferous greensand marl, extending along the northern border of the county, best seen at Moseley Ferry on the Brazos river, and on Big Cedar near Wheelock. in Robertson county..... | 565 to 600 feet. |



## RECENT.

Extending along the eastern side of the county deposits of alluvium or recent materials form a belt of from a half to one and a half miles wide. These are the bottom lands of the Navasota river, and are subject to a very general and deep overflow. The deposits are made up of brown tenacious clay, with considerable proportions of sand towards the upper end of the county, and are laid down in a more or less laminated condition.

On the western side of the county, and throughout the valley of the Brazos river, these recent deposits occur in bay-like areas, their continuity being frequently broken by the approach to the river and the formation of bluffs by the older underlying beds. The narrow strip of land lying between the Brazos and Navasota rivers in the southern, and the western area enclosed between the Brazos and Little Brazos rivers in the northwest corner of the county are both covered by deposits of recent formation.

In structure these deposits present no peculiarities differing greatly from the alluvial deposits found in many other portions of the river's course. Immediately adjoining the river the banks are made up almost entirely of a coarse massive sandy material showing few lines of stratification, and occasionally pockets or thin irregular deposits of a fine gravel. Great numbers of shells of the fauna still living in the river and along its banks occur scattered through these sands.

Behind the sandy banks of the river the inward portion of the plain is slightly lower in altitude, and the deposits more in the nature of a stiff tenacious brown colored clay.

The whole of the region occupied by these alluvial or fluvial deposits is more or less subject to overflows during the wet season, the depth and extent of which varies with the seasons, and frequently intervals of several years occur between the successive flooding. In the southern part of the county the average depth of overflow is between 5 and 10 feet. In excessively wet seasons some portions of this region are covered with 20 to 25 feet of water.

## QUATERNARY.

Quaternary deposits are but sparingly represented in Brazos county, and are made up almost entirely of brown sands and gravels, with isolated deposits of brown sandstones and conglomerates. The gravel consists mostly of pebbles of quartz, jasper, and silicified wood. Occasional pebbles of conglomerate, feldspathic rocks and blue carbonaceous shales, as well as brown and purplish brown crystalline rocks, occur scattered through the mass. Of these the white and yellow stained quartz pebbles are the

most abundant, and feldspathic crystals the rarest. The proportions of the pebbles of other origin vary in different localities, but with the exception of the silicified wood are never very numerous. Occasional stray pebbles of the flinty character, so common in the valley of the Colorado, are found, but they are very rare. Ferruginous pebbles occur in several places towards the north. These are, however, of local origin, and appear to be derived from the beds of ferruginous altered greensands found along the Robertson county line.

The gravel deposits are best developed in a low, broad, rounded ridge extending from near the Little Brazos river, on the John Williams league, in a slightly northeastern direction, through the A. McMahon, John McMillan, and other headrights, as far as the line of the Houston and Texas Central railway, on the Moses Baine league. This ridge is made up of ferruginous sandstones, brown sand, and considerable quantities of quartz and other pebbles. A section, where it crosses the railway, is shown in a cutting to be:

1. Brown sands and gravels, with thin seams of ferruginous sandstones at base..... 2 to 5 feet.
2. Gray sands..... 2 to 6 feet.

Towards the northern end of the ridge, where the Bryan and Hearne road crosses the north prong of Thompson creek, the section shown in the creek bank is:

1. Brown sands, mixed with ferruginous and quartz gravel..... 1 to 6 feet.
2. Laminated gray sand..... 5 feet.
3. Iron oxide<sup>e</sup>..... 1 foot.
4. Gray laminated clay, with sandy partings, to bed of creek..... 4 feet.

Going down the creek, or westward, the sand and gravel thickens rapidly and shows more distinctly. A section of the bank, 150 yards west of the last, gives:

1. Gray stratified sand..... 10 feet.
2. Gravel bed, mostly quartz pebbles and silicified wood..... 2 feet.
3. Gray cross-bedded sand..... 4 feet.

The line of separation between Nos. 1 and 2 of this section is distinctly marked, and the two lie unconformable with each other.

From this ridge northward, deposits of gravel occur covering the tops of the rounded hills, and on the O. Wilcox headright these gravelly pebbles and brown sands cover the whole surface to the depth of over two feet. Towards the south, on the southern side of the ridge, brown sand and pebbles become scarce, except in the vicinity of the different creeks flowing into the Little Brazos river.

Along the Brazos, and throughout the river valley, these deposits occur mostly in the form of pebbles of quartz, jasper, and silicified wood, with

a few worn fragments of Cretaceous shells and blue and brown crystalline pebbles. These gravels do not appear anywhere upon the surface, but are usually found in wells at depths ranging from 25 to 30 feet. A section of a bluff on the Brazos river, near Munson's shoals, shows their position and relation to the overlying river alluvium:

1. Brown river alluvium.....	18 feet.
2. Old humus, a black sandy soil mixed with brown sand and gravel	2 feet.
3. Pale blue clay.....	8 feet.
4. Brown sand.....	1 foot.
5. Coarse gravel, mostly white and stained quartz pebbles, and containing worn Cretaceous shells .....	2 feet.
6. Soft conglomeritic sandstone.....	2 to 4 feet.
7. Bluish green laminated lignitic clay, containing broken plant remains, visible.....	6 feet.

Along the southern margin of the lignitic sands and clays, and close to the contact of these deposits with the immediately overlying sandstones, small deposits of gravel occupy a narrow belt along the contact. They do not cover a very large area, but frequently have a thickness of from two to four feet.

Throughout the wide stretch of country lying east of Carter's creek gray sands cover the whole surface, and intermixed with and overlying them, quartz gravel and pebbles of worn silicified wood occur at irregular intervals and in ever varying proportions. Where the Bryan and Iola road crosses Wickson's creek a section on the east side of the creek shows:

1. Gray sand.....	2 feet.
2. Gravel.....	1½ feet.
3. Sand and gravel intermixed.....	1 to 6 feet.
4. Gravel.....	1 foot.
5. Stratified yellow sand.....	2 feet.

On the same creek, near the center of the west side of the G. H. Coleman league, the gravel is associated with a deposit of brown ferruginous sandstone in the form of bowlders ranging from one to four feet in diameter, and at Alexander church, on the G. W. Singleton league, similarly formed sandstones occur in conjunction with small bowlders of conglomerate.

From the divide separating the creeks flowing westward into the Colorado and those flowing eastward into the Brazos the character of these drift materials begins to change. The pebbles of flint, chert, quartz, feldspar, agate, and limestone, so strongly represented along the Colorado and the basin representing that river's drainage area, become fewer in numbers and in smaller quantities as the crest of the divide is reached from the west. Crossing the divide, and coming eastward, a few of these Colorado pebbles are to be found near the heads of the different creeks



lying in the Brazos river drainage area. These become less abundant as the river is approached, and very few pebbles of the Colorado materials appear within several miles to the west of the Brazos, and the occurrence of any such on the east side of the river is very rare. Except in the immediate channels of the Brazos and Little Brazos rivers, limestone pebbles have not been seen anywhere among the drift materials of Grimes, Brazos, or Robertson counties, and the few found in such positions have been derived from the Cretaceous limestones lying immediately to the north of these areas.

NAVASOTA BEDS.

The deposits described as the Navasota beds occur in the form of remnants, or in only a fragmentary condition, in Brazos county. The upper, or calcareous division, so largely developed in the southern portion of Grimes, and also occurring in Washington county, is altogether wanting in Brazos. The lower, or calcareous and non-calcareous sandstones and gray sand division, is represented by the lowermost quartzitic and semi-quartzitic sandstones and isolated patches of the gray calcareous sandstones found in the immediate vicinity of Navasota, Grimes county.\*

These deposits are confined to a small section lying in the extreme southern portion of the county, and are limited in their northern extension by a line of fossiliferous sandstones extending irregularly across the county a short distance south of the town of Wellborn. They comprise a series of light gray laminated calcareous sandstones and gray sands, having an approximate thickness of 150 feet, and are found in the area embraced in Barker's prairie, in the vicinity of Millican, extending southward and eastward to the edge of the river deposits bordering the the Navasota, and west to the alluvial deposits on the Brazos river. Small outliers occur at Hidalgo Falls, on the Brazos, and near the Washington bridge. A section on the west side of the river at the Washington bridge shows:

1. Alluvial brown sandy loam.....	5 feet.
2. Bluish gray sand, showing lines of stratification in places..	1 to 2 feet.
3. Indurated gray sand, with pockets of white sandy clay.....	4 feet.
4. Clay.....	½ to 1 foot.
5. Coarse gray sand.....	1 foot.
6. Sandy clay.....	1 foot.
7. Fine bluish gray sand.....	4 feet.
8. White clay in pockets.....	2 to 6 inches.
9. Gray sand and sandstones, irregular in structure.....	3 feet.
10. Clay.....	6 inches.
11. Coarse angular sand.....	10 feet.
12. Gray sandy clay.....	1½ feet.
13. Sandstone with streaks of clay, to water.....	3 feet.

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\* See Grimes county report, p. 9.

At Hidalgo Falls the sandstones extend, in the form of a ridge, diagonally across the river from the northeast to the southwest, and on the Washington county side, a short distance west of the river, are overlaid by a gray calcareous thinly bedded and lenticularly formed sandstone, which rises to an elevation of over 100 feet above the level of the river. These latter form a series of bluffs, which extend as a ridge northward for several miles.

The section shown along the southern side of Barker's prairie strongly resembles that seen in this Washington county ridge, as well as the ridge extending along the east side of the Navasota river in Grimes county.

The whole structure of this portion of Brazos, Grimes, and Washington counties bears unmistakable evidence of these sandstone beds having been laid down continuously across the whole area, and that active erosion carried on by both of the rivers has cut through and removed the greater portion of the beds and replaced the sandstones and sands by heavy deposits of river silt.

Numerous fossil remains have been reported from the overlying clays and conglomerates found in the neighborhood of Hidalgo Falls,\* but with the exception of a tooth of a mastodon no remains were obtained by us.

#### EOCENE.

Immediately underlying the Navasota beds come the great series of Eocene deposits, which extend from the latitude of Wellborn station northward throughout the whole of the northern portion of the county. The line marking the southern margin of these beds, beginning on the Navasota river on the J. Gray headright, passes westward along the north side of the Robert Matthews headright to the southeast corner of the N. Clampett headright, thence southwest through the Samuel W. Robertson league, to the south corner of the Thomas Caruthers league, thence through the Robert Stephenson league to near Wellborn and southwest to the Brazos river.

The Eocene deposits admit of a separation into three divisions, each widely separated from the other in structure and lithological conditions, although closely united by their contained fauna. The beds have been divided, according to their lithology, into the following divisions:

1. Gray sandstone, containing *Cardita planicosta* and other Eocene fossils in some localities, and in others leaves and stems of plants..... 65 to 90 feet.

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\*The Miocene beds are surmounted at some localities, as at Hidalgo Falls, with a pebbly deposit cemented with ferruginous matter into a coarse pudding stone or conglomerate. This deposit has yielded in more or less abundance the bones of Mastodon, Elephas, Megalony, Equus (*E. fossilis*), Crocodilus, and Testudo. (B. F. Shumard, Trans. St. Louis Academy of Science, Vol. II, p. 141.)

- 2. Thinly bedded gray and dark gray sandy clays, laminated and thinly bedded sands and clays, with thin seams of lignite and gypseous clays..... 900 feet.
- 3. Brown ferruginated fossiliferous greensand marls, green sands and green clays, with occasional seams of lignite..... 650 feet.

1. GRAY SANDSTONES.— These sandstones, with their accompanying gray sands, although here tentatively denominated the Wellborn beds, belong to, and help to form a part of, the series of gray sands and sandstones extending across the State from the Neches river in Polk county as far west as Sunnyside church, in Lee county.

In Grimes county these beds have narrowed down to a belt occupying an irregular area lying between the calcareous sands and sandstones of the Navasota beds and the underlying dark gray sands and lignites of the lignitic group, and appear only as isolated patches.

In Brazos county the gray sands and sandstones form an irregularly defined belt of varying width extending across the county from the edge of the Navasota bottom lands on the east to the Brazos river on the west. They are hard, close-grained, and compact, occasionally showing a tendency to become quartzitic. The country occupied by them is generally flat and prairie-like, covered by gray sand, and few outcrops or continuous ledges of the sandstones can be seen anywhere.

Small outcrops occur at several places on the Sam Davidson and James Hope leagues, on the western side of the county, where the belt has an apparent width of nearly three miles. These outcrops are irregular in areal extent and thickness, and appear usually as isolated patches or “knobs” surmounting the small rounded hills forming the uplands of this region. The sandstones here rest upon the upper beds of the lignitic sands and clays found farther north. A section on a small creek on the south side of the James Hope headright shows:

- 1. Gray sand and gravel ..... 1 foot:
- 2. Gray sand, with great quantities of silicified wood..... 5 feet.
- 3. Gray indurated sand, with ledges of soft sandstone ..... 10 feet.
- 4. Gray sandstone, jointed and thinly bedded ..... 8 feet.
- 5. Dark brown lignitic clay, showing yellow streaks and sulphur efflorescence..... 20 feet.

Near the mouth of White’s creek the gray sandstones are seen capping the higher grounds. Here these rocks are arranged in three ledges, showing an aggregate thickness of 20 feet, and rest upon the dark brown clays of the lignitic deposits. No fossils have been obtained from them, except a few small dicotyledenous leaves, but their direct continuity with the fossil bearing sandstones has been traced along a series of small outcrops across the county by way of Minter Springs and Wellborn to the junction of the two on the R. Stephenson league.

Going east from Wellborn, light gray laminated sandy clays and thin

\*6—Geol



beds of sandstones appear in the cuttings and washouts along the south side of the R. Stephenson league for a distance of several miles. About three miles to the southeast of the station, at Dr. Williams' quarry, on the same league, an exposure of regularly bedded gray sandstones appears along the north bank of a small stream. The general section at this place appears to be:

1. Gray sands, showing some distance down the creek..... 2 to 8 feet.
2. Thinly laminated light gray (almost white) sandy clays..... 2 to 8 feet.
3. Broken deposit of sandstone, containing fossils..... 2 feet.
4. Regular and even bedded gray fossiliferous sandstone..... 6 feet.

The fossils have been determined by Mr. G. D. Harris to be Eocene, and of Claiborne age, and comprise such species as *Yoldia compsa*, Gabb., *Cardita planicosta*, Lam., *Cytheræa dicoidalis*, Con., *Maetra*, sp., *Corbula nasuta*, Con., *Solen*, sp., *Cylichna kelloggii*, Gabb., *Turritella mortoni*, Conrad, and others. The fossiliferous rocks are confined to a small area extending but a few hundred yards along the creek, and having an exposed width of only between 50 and 100 feet.

Throughout the region known as Rock prairie the same series of gray sandstones may be seen exposed in small outcroppings, and on the N. Clampitt headright they appear in the form of a ledge from 18 to 25 feet in thickness. In this place the sandstones form two beds, of which the upper shows a face from three to five feet in thickness. The same sandstones have also been found in wells in this neighborhood at a depth of 60 feet, but so far as known are unfossiliferous.

2. THINLY BEDDED GRAY AND DARK GRAY SANDY CLAYS, LAMINATED AND THINLY BEDDED SANDS AND CLAYS, WITH THIN BEDS OF LIGNITE AND GYPSEOUS CLAYS.—These beds occupy the greater portion of Brazos county. Their northern boundary, forming an irregular line, beginning on the Navasota river about two miles south of the old San Antonio road crossing, in the northeastern corner of the county, and extending in a general southwest course approximately parallel to the old San Antonio road as far as Benchley, a distance of eighteen miles, and thence turning nearly south to the Brazos river, nearly a mile south of the confluence of that river with the Little Brazos. Their southern edge passes under the the gray fossiliferous sandstones in the vicinity of Wellborn, near the southern end of the county.

The portion of the county occupied by these beds is generally level or slightly rolling and prairie-like, covered throughout the greater extent by a light colored to dark gray sand with scattering pebbles, and for the greater part nearly devoid of timber of any kind. A few small trees of post oak, black jack, and cottonwood grow along the banks and narrow bottoms of creeks, and occasional "motts" or small areas covered with the same class of timber dot the higher levels.

Few creeks of any size intersect these beds. The larger ones have usually narrow, deep channels, showing clear cut sides often to the depth of twenty or more feet.

The beds admit of two divisions, the basal being a heavy clay containing selenite or gypsum crystals, some of these twinned and having the appearance of arrowheads. The upper division comprises a series of laminated gray and thinly stratified deposits of gray and brown or pink colored sands and dark brown and blue clays, with occasional thin seams of lignite and lignitic materials.

The sections obtained present a decidedly uniform appearance everywhere. A section on Bee creek, in the northeast corner of the county, shows:

- |   |           |
|---|-----------|
| 1. Brown soil .....   | 6 inches. |
| 2. Brown sand .....   | 5 feet.   |
| 3. Thinly stratified yellowish gray sands and dark brown clay, with thin streaks of lignite, the deposits lying in beds from 2 to 6 inches in thickness ..... | 22 feet.  |

Four miles southwest of Tabor, near the Wheelock and Bryan road, a section shows:

- |                                     |           |
|-------------------------------------|-----------|
| 1. Gray prairie loam .....          | 1½ feet.  |
| 2. Mottled gray and brown sand..... | 4 feet.   |
| 3. Ferruginous sandstone.....       | 3 inches. |
| 4. Coarse bluish sand.....          | 1 foot.   |

On Bowman's creek a section near the center of the Bowman league shows:

- |   |         |
|---|---------|
| 1. Black soil of overflow land .....  | 3 feet. |
| 2. Dark gray, changing to a brown, sandy clay, containing blocks of silicified wood ..... | 8 feet. |

In Thompson's creek, near mile post 101 of the Houston and Texas Central Railway, the lowest deposit seen in the bed of the creek is a dark grayish and bluish green sand, having a very slight dip toward the south-east.

In the neighborhood of Harvey Postoffice, five miles southeast of Bryan, wells dug from 25 to 30 feet pierce a thin seam of lignite not exceeding two feet in thickness.

The whole of the region lying between these sections is covered with gray sand, having a light gray, almost white, subsoil, and underlaid by thinly laminated sandy clays and dark gray sand deposits. Lignite deposits, from six inches to two feet thick, are reported from nearly every well in this area, found at a depth of about 40 feet, and water is usually obtained in a white quicksand at a depth varying from 60 to 90 feet.

Along the western side of the county the creeks are usually much deeper. Sections obtained in this area show the same characteristics. A

section on Turkey creek, on the east side of the T. J. Wooten league, shows:

- |   |                |
|---|----------------|
| 1. Gray surface sand, containing pebbles of quartz and silicified wood .....                    | 1 foot.        |
| 2. Unstratified gray sand, showing no dip, but overlying the succeeding bed unconformably ..... | 10 to 15 feet. |
| 3. Thinly laminated dark brown sand, with lignitic partings and broken plant remains .....      | 8 feet.        |
| 4. Darker laminated and more lignitic sands and sandy clays ....                                | 9 feet.        |
| 5. Dark brown lignitic sands, thinly stratified and showing cleavage joints. ....               | 4 feet.        |
| 6. Light grayish blue sands, with perpendicular joints running east and west, visible.....      | 4 feet.        |
- These beds dip south 20 east from 3 to 5 degrees.

In this neighborhood wells bored to the depth of 100 feet pass through the same class of materials as comprised in this section through the whole of their depth.

At Jones' bridge across the Brazos, a section of the bluff beneath the bridge shows:

- |   |          |
|---|----------|
| 1. Yellowish gray surface sand.....   | 20 feet. |
| 2. Thin seam of sandy soil, showing about 300 feet above the bridge...                            | 2 feet.  |
| 3. Same as No. 1 .....  | 10 feet. |
| 4. Bluish green sandy clays, containing fragments of lignite and breaking into ovoid blocks.....  | 4 feet.  |
| 5. Bluish sandy clay .....  | 12 feet. |
| 6. Greenish sandy clay, with lignitic patches, breaking into nodules and partially laminated..... | 7 feet.  |
| 7. Covered up, but probably the same as No. 6.....  | 5 feet.  |
| 8. Same as No. 6 .....  | 8 feet.  |
- These beds dip slightly east of south and about 5 degrees.

This bluff extends about 300 yards along the river, and is covered up at both ends by deposits of recent river drift.

Going up the river about two miles, Munson's shoals are reached. These shoals are formed by a bluish green lignitic clay, containing great quantities of broken plant remains. A section on the Brazos county side of the river shows:

- |  |              |
|--|--------------|
| 1. Brown river loam.....   | 18 feet.     |
| 2. Old humus, black sandy clay or clayey loam, mixed with brown sand containing a few drift pebbles.....                           | 2 feet.      |
| 3. Pale blue clay.....   | 8 feet.      |
| 4. Brown sand.....   | 1 foot.      |
| 5. Gravel, containing worn Cretaceous shells.....  | 2 feet.      |
| 6. Soft conglomeritic sandstones.....  | 2 to 4 feet, |
| 7. Bluish green lignitic clay, breaking into blocks and containing broken plant remains, and extending across the river, visible.. | 6 feet,      |

Throughout the region contiguous to the Brazos river, from White's



creek southward, until the overlying gray sandstones are reached, the country presents the same rolling sandy characteristics found along the eastern and northeastern portion of the county.

Two and a half miles south of College Station the section shown in a small tributary of White's creek is as follows:

1. Dark gray sandy soil..... ½ to 1 foot.
2. Unstratified gray sandy clay ..... 5 feet.
3. Thinly stratified gray sandy clay to bottom of creek..... 7 feet.

On the main stream of White's creek, near where the public road crosses, the bank shows a section of:

1. Gray sandy soil ..... 1 foot.
2. Unstratified clayey sand..... 20 feet.
3. Thinly stratified and laminated gray sandy clay..... 4 feet.

Dip, southeast 5 degrees.

Small fragments of lignite occur scattered along the bed of this creek for nearly a mile. They are mostly fresh in appearance, and do not appear to have traveled far, although no outcrop could be seen.

Along the Brazos, and generally throughout the James Hope and Sam Davidson leagues, the gray sandstones, wherever visible, are underlaid by a heavy deposit of brown colored, thinly stratified, and laminated lignitic sandy clay, showing an efflorescence of sulphur, and in many places having yellow laminae intermixed with the brown sands. A well bored at the Agricultural and Mechanical College is reported as passing through upwards of 900 feet of these lignitic deposits before reaching the underlying fossiliferous greensands and clays.

Wells in the neighborhood of Bryan obtain water in these clays at depths ranging from 60 to 80 feet. In one of the wells part of the lower jaw of a crocodile, (*Crocodylus*, sp.), was found at the depth of 72 feet. The general section of the wells in the neighborhood of Bryan is:

1. Gray sand..... 1 to 3 feet.
2. Thinly stratified and irregular laminated gray sands and pinkish gray clays ..... 60 feet.
3. Bluish gray sand, with water..... 10 feet.
4. Laminated dark gray clay, with broken plant remains and *Crocodylus*..... 15 feet.
5. Dark blue sand, with water.....

The basal division of these beds comprises a series of heavy clay deposits containing great quantities of gypsum in the form of selenite. Many of the crystals are beautifully formed, and frequently twinned in the form of arrow heads. In the northeastern portion of the beds the gypsum occurs in large blocks of irregular form.

Small exposures of this division occur along the prongs of Bee creek, near its head on the W. C. Sparks league, and also along the northern

end of the George W. Singleton league. In the neighborhood of Benchley, on the L. W. Laughlin league, a cutting on the Houston and Texas Central Railway shows the gypseous clays extending along the road over a mile. A section at this place shows:

1. Brown sand and gravel..... 3 to 5 feet.
2. Brown coffee colored clay, with great quantities of gypsum.. . . 2 to 6 feet.

Westward, on the southeast corner of the O. Wilcox league, the gypsum appears only as minute crystals disseminated through a brown clay. A section of a small brook in this region showing:

1. Pebbles ..... scattering.
2. Black clayey soil, showing efflorescence of gypsum..... 1 to 4 feet.
3. Brown clay, breaking into cuboidal blocks and containing crystals of gypsum..... 2 to 6 feet.
4. Brown sand..... 1 foot.

These deposits lie apparently in an unconformable manner upon the fossiliferous greensand marls belonging to the Claiborne group proper, as shown in the Moseley Ferry and Cedar creek sections.

3. BROWN FERRUGINOUS GREENSAND MARLS, GREENSANDS, AND GREENISH BLUE CLAYS. — The lowest deposits found in Brazos county are a series of brown ferruginated greensand marls, greensands, and greenish blue clays, with occasional thin beds of irregularly deposited lignite.

The beds belonging to this series form a western extension of the Cook's Mountain series of the upper marine Eocene, and approximately lie in the same horizon as the beds found at Alto, in Cherokee, and on Hurricane bayou and Alabama bluff, on the Trinity river, in Houston county. The Brazos county beds, like those of corresponding age east of of the Trinity, contain an abundant and well preserved fauna. These beds have not yet been connected stratigraphically with the Houston county or Trinity river beds, although they have been traced from the Brazos eastward across Brazos county to the Navasota river, and for a short distance into Madison county. They are also known to occur at several intermediate points in Leon county.

Palæontologically, as well as as lithologically, the Houston county beds present a strong affinity to those of Brazos county in several respects, more particularly in the occurrence of the *Spirorbis leptostoma*, Swain, and *Plicatula filamentosa*, Conrad, as well as several other species. The former of these fossils was described in the Houston county beds under the name of *Vermetus*, a name now found to be incorrect. These two fossils appear to be the characteristic forms belonging to the uppermost beds of this horizon, and occur in great numbers at all the places where the beds are seen in Leon, Madison, Robertson, and Brazos, as well as at Alabama bluff and Hurricane bayou.

These beds immediately underlie the gypseous clays and sands forming

the base of the Yegua or lignitic division of the Claiborne, and the want of conformity noticed towards the eastern portion of the State, in Cherokee county and in Houston county, is also noticeable in Brazos county.

This want of conformity between the greensands and the overlying lignitic or estuarine deposits is marked in Brazos county by the presence of boulders of altered fossiliferous sandstones found occasionally imbedded in the lignitic sands.

Five miles north of Bryan, where the Bryan and Hearne public road crosses the south prong of Thompson's creek, a section showing the presence of these fossiliferous boulders in the lower portion is as follows:

1. Dark gray sandy soil ..... 1 foot.
2. Dark gray sandy subsoil ..... 1½ feet.
3. Yellow and brown stained sand, containing quartz and ferruginous gravel and silicified wood in lower division ..... 2 feet.
4. Thin broken stratum of fossiliferous sandstone ..... 8 inches.
5. Yellowish gray sandy clay, with boulders of iron containing casts of *Cardita planicosta* and other fossils, visible ..... 4 feet.

The well boring at the Agricultural and Mechanical College entered a dark blue fossiliferous clay at a depth of between 900 and 1000 feet. This represents the blue clay No. 5 of the Moseley ferry section, and not the upper beds containing the *Spirorbis leptostoma* and *Plicatula filamentosa* seen near Benchley, which, had they been present in this locality, should have been found in the boring at 650 feet. These sands with their accompanying fossils were not found, and from their absence it may be inferred that about 250 or 300 feet of fossiliferous greensands and clays had been removed by erosion before the deposition of the gray sands and gray and blue lignitic clays.

The portion of the beds belonging to this series found in Brazos county occupies a narrow belt not exceeding four miles in width at the northeastern end, and five miles in the southwestern or Little Brazos area. This belt extends along the northern end of the county in a generally southwesterly direction as far as the Houston and Texas Central Railway in the neighborhood of Benchley station, whence the line of contact between these and the overlying Yegua or lignitic beds turns in a southerly direction and extends in a line approximately parallel to the course of the Little Brazos river, crossing the Brazos about half a mile south of the confluence of the two rivers.

The country occupied by these deposits, in the northern part of the county, forms an extension of the great Wheelock prairie, and is level or slightly rolling. Towards the western portion, the country becomes hilly and rough, showing a series of rugged bluffs along the eastern bank of the Little Brazos river.

In the western portion of the county the sequence of these beds is best



seen in the section shown in the bluff on the western side of the Brazos river at Moseley's ferry. The section is:

- |  |           |
|--|-----------|
| 1. Brownish yellow surface loam .....  | 15 feet.  |
| 2. Thin stratum of fossiliferous iron ore, in boulder form .....   | 6 inches. |
| 3. Blue laminated fossiliferous clay .....   | 3 feet.   |
| 4. Fossiliferous iron ore, running under the river about 100 yards below the ferry .....   | 2 feet.   |
| 5. Laminated fossiliferous blue clay .....   | 6 feet.   |
| 6. Fossiliferous iron ore .....  | 2 feet.   |
| 7. Altered fossiliferous greensand, found in north end of bluff ....   | 10 feet.  |
| 8. Thin stratum of fossiliferous iron ore .....  | 2 feet.   |
| 9. Greensand, containing great quantities of fossils, dark green near ferry, but becoming a brown at north end, and merging into No. 7, measuring at ferry .....   | 5 feet.   |
| 10. Thinly laminated blue clay, changing into brown near top, and weathering to a light blue toward the bottom; the upper brown portion is fossiliferous and the lower blue contains occasional crystals of selenite ..... | 15 feet.  |
| 11. Dark, almost black, fossiliferous sandy clay .....   | 10 feet.  |
| 12. Thin seam of black clayey sand, jointed and stained brown along joints and on outside, apparently unfossiliferous .....  | 1 foot.   |
| 13. Same as No. 11, extending into river .....   | 8 feet.   |
| No. 13 also forms a ledge six feet deep in the river .....   | 6 feet.   |
- The dip of these beds is south 30 east.

This region was visited by Dr. Ferdinand Roemer in 1847, who says:

“While on a tour to the upper Brazos I discovered, in the neighborhood of the town of Caldwell, strata of a ferruginous sandstone with numerous well preserved Tertiary shells. Crossing afterwards the Brazos, not far from this town, I had a still better opportunity to see this formation along the steep banks of this river. It consists of alternating strata of brown ferruginous sandstone and of dark colored plastic clays, both teeming with fossils.”\*

The bluff is about 1500 feet long and from 25 to 30 feet high, and with the exception of the upper 15 feet of brownish yellow sandy loam is fossiliferous throughout. The fossils, in addition to being very plentiful, are all in a very good state of preservation and easily obtained.

The upper laminated clays and the beds of fossiliferous iron ore are again seen in the bank of the Little Brazos river near the iron bridge on the Bryan and Caldwell road, about two miles east of the ferry, and stretch for some distance both up and down the river. A section near the bridge shows:

- |  |                |
|--|----------------|
| 1. Chocolate brown clayey soil .....     | 10 to 15 feet. |
| 2. Gravel .....                          | 2 to 4 feet.   |
| 3. Laminated unfossiliferous clays ..... | 4 feet.        |
| 4. Pale blue clay, unfossiliferous ..... | 1 to 3 feet.   |

\* American Journal of Science and Arts, Vol. VI, second series 1848, p. 23.

- 5. Thinly laminated blue to black fossiliferous clay..... 6 feet.
- 6. Thin stratum of fossiliferous iron ore..... 1 foot.
- 7. Fossiliferous green clay..... 3 to 8 feet.

In this place the section shows the Eocene deposits to be in contact, although unconformably, with the drift gravel, and the gravel itself overlaid by 10 to 15 feet of river alluvium.

Five hundred yards south of the mouth of the Little Brazos river a section of a bluff near Wellborn shoals shows:

- 1. Black soil..... 2 feet.
- 2. Brown loam, with limy concretions..... 25 feet.
- 3. Fine brownish yellow sand, with occasional streaks or pockets of gravel..... 15 feet.
- 4. Gravel, with water-worn Cretaceous shells..... 2 to 4 feet.
- 5. Pale blue unfossiliferous clay..... 5 feet.
- 6. Dark green sands, showing fossils in lower portion (this sand forms a portion of Wellborn shoals)..... 2 to 5 feet.
- 7. Dark colored laminated fossiliferous sandy clay, running under the river 300 yards below mouth of Little Brazos, and forming upper portion of shoals ..... 4 feet.
- 8. Ferruginous sandstones..... 8 inches.
- 9. Same as No. 7.....

This section shows the last of the fossiliferous greensands and clays found in the Brazos river section.

The east bank of the Little Brazos river, from the north side of the D. Harvey survey northward to the Robertson county line, is formed of a succession of bluffs showing small exposures of fossiliferous ferruginous sandstones, and on the O. Wilcox and Wilson Reed headrights the region is covered by a yellowish brown sand containing nodules of iron ore and sandstone, with fossils. The fossils here are chiefly *Plicatula filamentosa*, Conrad, *Spirorbis leptostoma*, Swain, and fragments of *Cardita planicosta*, Lamarck, and a few other broken and indistinct forms. This assemblage corresponds somewhat closely to that found on the prairies near Wheelock, and in the northeastern portion of the county near the Madison county line.

In the eastern portion of the county the prairie character of the surface prevents the obtaining of many sections, and those obtained are generally very small. A section on Town branch, one of the tributaries of Bee creek, shows:

- 1. Black surface soil..... 1 to 3 feet.
- 2. Dark brown gypseous clay..... 1½ feet.
- 3. Brown fossiliferous sandstone..... ½ foot.
- 4. Brown fossiliferous clay..... 1 foot.
- 5. Brown fossiliferous sandstone..... ½ foot.
- 6. Brown fossiliferous clay..... 1 foot.
- 7. Blue laminated clay, in which no fossils were seen, to bed of branch ..... 2 feet.

The continuation of these beds, as seen near the Navasota river in the northeastern corner of Madison county, shows the following section:

1. Brown sand, gravel, and conglomerate, in boulders ..... 20 feet.
2. Brownish yellow fossiliferous sand, containing *Spirorbis leptostoma*, Swain, *Plicatula filamentosa*, Conrad, and other fossils..... 2 feet.
3. Ferruginous sandstone, containing *Plicatula filamentosa*, Conrad, in great numbers..... 1 foot.
4. Brown sand..... ..

## ECONOMIC GEOLOGY.

### SOILS.

The soils of Brazos county, with the exception of the bottom lands, although nearly all fit for cultivation, may be classed as poor. In the region of Barker's prairie, in the southeastern part of the county, and also in several portions of the area occupied by the gray sandstones of the Wellborn beds of the Fayette division of the Eocene, the gray sandstones appear on the surface over considerable tracts, and at other places the gray sandy soil of these beds is too thin and scant for cultivation. The soils belong altogether to the two grades, alluvial or sedimentary, and residual or sedentary.

**ALLUVIAL.**—The alluvial soils are found almost exclusively along the bottom lands of the Brazos river. A narrow strip extends along the west side of the Navasota river, and a few of the larger creeks have small bottom lands near their mouths. The bottoms connected with the Navasota, as well as those of the creeks, are comparatively unimportant, and but a very small part of them is under cultivation.

In the valley of the Brazos these alluvial soils form a belt extending with some small intermissions along the whole western side of the county. This belt has a width from one-half to two and a half miles. Alluvial soils cover an extensive area in the southern portion of the county, and the whole of the region between the two Brazos rivers, and the areas are all more or less subject to overflow.

The alluvial soils are altogether a brown clayey loam, changing occasionally into a stiff brown clay, and at other places to a brown sand or sandy loam. They are usually easily worked and as a class very productive.

**RESIDUAL SOILS.**—The greater portion of the county is occupied by a light gray sandy soil containing scattered deposits of gravel and coarse sands. These soils have been derived from the underlying lignitic deposits, varying in thickness from one to two feet, and are a fine-grained sandy loam, with a considerable excess of sand, of dark grayish color, readily leaching to a pale yellowish gray or white. The subsoil is gen



erally a brown or dark brown sandy clay. These soils are generally poor, although warm and early, and easily cultivated at any season of the year. They rapidly deteriorate under prolonged cultivation, and in a few years are said to lose over half of their productive power. These gray sands frequently form extensive prairie regions, the soils of which vary but slightly in quality and texture from those of the rest of the district. The soils belonging to this class are not much cultivated, and large areas are used for the production of hay and stockraising.

In the northeastern portion of the county the soil found on Wheelock prairie is a dark brown or black sandy loam, varying in thickness from a few inches to over one foot. It is considerably spotted. In places it is extremely fertile, but at others the close proximity of a ferruginous sandstone to the surface renders the area unavailable for farming purposes. This region is mostly used for grazing purposes.

#### BUILDING STONES.

The building stones are almost altogether confined to the hard gray sandstones of the Wellborn beds. Small deposits of a coarse, soft, brown colored sandstone occur on the McMillan and Williams headright, about four miles west of Bryan, but these deposits are of comparatively little value.

Isolated patches of gray sandstone occur on the James Hope league, and on the Sam Davidson league much larger deposits occur. These have been quarried in the neighborhood of Wellborn and Minter Springs for building purposes.

In the Rock prairie region, on the Stephenson and Robertson leagues, as well as on the N. Clampett headright, deposits of a close-grained, firm sandstone occur, which can be obtained in blocks of large size and admit of fine dressing. A quarry on the N. Clampett headright supplied the foundation stones for some of the Agricultural and Mechanical College buildings a number of years ago.

Coarse gray calcareous sandstones of the Navasota beds occur in great quantities in the neighborhood of Barker's prairie. They belong to the same grade as those in the region around Navasota, in Grimes county, and are very little used.

#### CLAYS.

The clays of the county are generally of little value. Brick earths occur at many places, but except at Bryan, no brick making is carried on. Three small yards are in operation in the town of Bryan, and so far as can be ascertained their whole output does not exceed 500,000 to 750,000 bricks annually.

Peter Winter's yard.—This is the most extensive yard in the city. The bricks are made on a New Quaker horse-power machine having a daily capacity of 10,000. The bricks are dried under cover and burned altogether by wood. This yard employs thirteen hands and represents a capital of \$3000. The total output for the season 1892 was 600,000. No bricks are repressed.

B. H. Knowles' yard.—This is a small yard, employing only a few men. The bricks are hand made and dried on yard. The capital invested does not exceed \$1000.

Lawrence Conway's yard.—This is the smallest yard in the district, and is not worked regularly. The bricks are hand made, and are dried on the yard, and the total output of 1892 was one kiln of about 100,000.

The bricks made in these yards are dark brown in color and of only a medium hardness. They may be classed as a fair grade of No. 2 brick. The other clays found in the county are of no economic value.

#### BROWN COAL.

Lignitic sands and clays occur through the whole of the northern half of the county, and thin seams or deposits of lignite occur at depths ranging from 30 to 60 feet.

The brown coal deposits are usually found in digging wells, and no reliable information can be obtained regarding their quality or thickness. In the northwestern part of the county a deposit crops out in the bank of the Brazos river near Neblet or Black shoals. It stretches across the river into Burleson county, and on the Brazos county side has a thickness of from 12 to 14 feet, as shown in the following section:

1. Bluff loam or river deposits .....	6 feet.
2. Brown clay .....	3 feet.
3. Yellow sand, with gravel near bottom.....	10 feet.
4. Brown coal, shaley near top, but becoming compact at base of bed .....	12 to 14 feet.
5. Lignitic sand .....	

An analysis of the brown coal in this bed made by Dr. W. H. Melville, chemist of the Survey, shows it to have the following composition:

Moisture .....	18.33 per cent.
Volatile matter .....	52.62 per cent.
Fixed carbon .....	24.88 per cent.
Ash .....	4.17 per cent.
	100.00
Sulphur .....	.87 per cent.

Of the Brazos river brown coals this deposit can probably be utilized the most economically. The coal can be readily obtained by stripping,

and the transportation facilities are exceptionally good. The Hearne and Brazos Valley Railway passes within two miles, and the level tract of country between the river and the railway line would greatly facilitate the construction of a siding or branch to the mine, which might be built at the minimum cost allowed for this grade of work. At some stages of the river transportation can also be obtained by barges.

#### TIMBER.

Brazos county can scarcely be considered a timbered region. Of the 519 square miles forming the complete area, not more than 175 contain any timber at all, and of this the largest part is found in the bottom lands and in narrow tracts skirting the banks of the water courses. Post oak and blackjack, with a thin scattering growth of hickory, occupy the wooded areas of the higher grounds, and elm, ash, pecan, pin oak, and cottonwood form the growth of the bottom and second bottom lands.

#### WATER SUPPLY.

The drainage of the county has an eastern and western fall—on the east to the Navasota river, and on the west to the Brazos. The greater portion belongs to the eastern area and is drained by Big Cedar, Sandy, Bowman, Brushy, Carter's, and Jones' creeks, with several smaller tributaries to these, and a few small streams flowing directly into the Navasota. On the west the drainage channels are the Little Brazos, Thompson, Turkey, White's, and Hope's creeks. These streams contain very little water during the summer and dry seasons, and with the exception of the larger ones, provide but a scanty supply of water for any purpose whatever.

Very few springs occur, but water can generally be obtained from wells at various depths. In the east water is obtained from the lignitic sands, at depths ranging from 60 to 90 feet. In the neighborhood of Bryan the water is usually reached at from 80 to 85 feet, and still larger and more enduring streams are found between 90 and 190. The water for the Bryan water works is obtained from three wells, the largest of which pierces the 190 foot stream. In the southern portion of the county, water is generally obtained from comparatively shallow wells, none of which exceed fifty feet in depth. It is generally poor, being impregnated with sulphate of iron. Storage tanks and cisterns are very generally resorted to for the accumulation and preservation of water for household and stock purposes.

For agricultural purposes the rainfall is generally ample, the annual



precipitation being about 42 inches, very evenly distributed throughout the year, the proportion being:\*

Winter months—December, January, February.....	11.95 inches.
Spring months—March, April, May.....	13.81 inches.
Summer months—June, July, August.....	6.15 inches.
Fall months—September, October, November.....	8.53 inches.

2. ARTESIAN WELLS.—The census bulletin No. 193† places the total number of artesian wells in Brazos county at 15 and gives their depth as 228 feet for shallow wells, and 470 for deep wells, and averages the depth at 330 feet. According to the same bulletin the average flow is four gallons per minute, and the average cost for each well \$407. Since this bulletin was issued a number of other wells have been bored.

These wells are all located in the limits of the Brazos river valley, all along the river from the mouth of the Little Brazos northward to the Robertson county line. The water is usually found in a quicksand, at depths ranging from 150 to 340 feet, but the greater number obtain their supply at between 210 and 240 feet.

At Steele's store, on the Brazos Valley Railway, a well obtained a fair flow of good water at 230 feet, but in order to increase the flow it was sunk to its present depth of 330 feet, where a much better and stronger stream was obtained; and at Stone City another well provides a similar stream at about the same depth.

In going northward the wells appear to deepen in places, as at Mumford the water is found at depths ranging from 160 to 800 feet. The stream flowing from wells between 160 and 230 feet is not strong, while that from greater depths is good and lasting, although slightly thermal.

These wells are all made with a small bore, and obtain their water supply from a fine blue sand which frequently chokes the pipes.

The chances of obtaining a good artesian water supply anywhere in the higher levels of the county are extremely problematical, and at best doubtful. A well bored at the Agricultural and Mechanical College, at about the same elevation as Bryan, to a depth of 1400 feet, found a large supply of water at 700 feet; but at this depth the water only rose to within 100 feet of the surface, and in the 240 foot well of the Bryan Water and Light Company the water only rises to within 140 feet of the surface.

The elevation of the mouth of the well at the College is 350 feet above tide level, and that at Steele's store 253 feet. The distance between these two points is approximately ten miles in a west by south direction, and assuming the dip of the underlying water-bearing sands to be approximately uniform at the rate of 30 feet per mile, or a little less than half

\* Report Chief Signal Officer for 1890, p. 729.

† Bulletin No. 193, Eleventh Census, 1890, p. 5.

of the measured dip at Moseley's ferry, the same flow of water obtained at Steele's store at 330 feet should be found in the College well at 730 feet approximately. This depth corresponds within about 30 feet of the depth at which the water reported from this well is obtained. This will be better understood from the following figures:

Elevation of well at College.....	350 feet.
Elevation of well at Steele's store.....	253 feet.
<hr/>	
Difference in elevation.....	97 feet.
Depth of well at Steele's store.....	330 feet.
Dip 75 feet per mile south 30 degrees east. Steele's store is almost due west of the College; the dip is therefore a little less than half, or say 30 feet per mile for a distance of 10 miles.....	300 feet.
<hr/>	
Water should be found at College at.....	727 feet.

The water found in the well at the College is apparently the same stream as that supplying the Brazos valley wells, and the fact of its not rising to the surface is due to the higher elevation. Reasoning from these premises, it may be inferred that unless an intermediate stream be met near Bryan, a condition extremely unlikely, no artesian water will be found, and the best that can be expected from the new 1200-foot well will be water approaching within 120 feet of the surface.

3. NAVIGABLE STREAMS.—There are no navigable streams either within or adjacent to Brazos county. The two rivers, the Navasota and Brazos, are not navigable in this region. The Navasota is small and full of fallen timber and snags, and liable to extremely sudden rises and falls, and the Brazos is crossed by Hidalgo falls near the southern end of the county, and by a number of shoals at irregular distances from the falls northward.

4. MINERAL SPRINGS.—Only two mineral springs or wells are known to exist. Manganic wells are a series of shallow wells about three miles northwest of Bryan, and the other, Boiling or Sulphur spring, occurs on the west bank of the Navasota river on the J. Gray headright. This last is a sulphur water, highly charged with sulphuretted hydrogen. Both of these localities are used as pleasure or health resorts, and have local reputations.

## CHAPTER III

### ROBERTSON COUNTY.

#### GEOGRAPHY AND TOPOGRAPHY.

Geographically, Robertson is one of the great group of central Texas counties; and geologically, it forms part of the western extension of the high, flat-topped, iron ore-capped region of East Texas. The northern boundary is formed by Falls and Limestone counties, the Navasota river extends along the eastern, Brazos county lies across the southern, and the Brazos river forms the western boundary. The whole area is computed at 869 square miles.

The topography is varied. The northern portion is undulating, interspersed with small prairies; considerable areas of mesquite prairie occur along the western side, from near Bremond southward to the neighborhood of Hearne; great stretches of bottom and second bottom lands spread out along the rivers; and the southeastern portion is almost altogether prairie.

The high lands, with flat ore-capped hills occurring in the counties to the eastward, are represented in Robertson by a westward prolongation of high sandy and ferruginous sandstone ridges, which enter from Leon on the east and stretch in a general southwest direction across the county, at an ever decreasing elevation, until they end in a series of small, isolated bluffs along the eastern side of the Little Brazos river. Throughout these ridges the iron ore of the eastern counties is replaced by a coarse-grained conglomeritic ferruginous sandstone.

The general elevation of the county is approximately 400 feet above sea level. Some portions reach an altitude of 450 and 470 feet, but the greater part lies much lower. The elevations of the principal points are:

Benchley.....	306 feet.
Sutton.....	370 feet.
Wheelock.....	453 feet.
Hearne.....	305 feet.
Franklin.....	404 feet.
Lake.....	314 feet.
Calvert.....	337 feet.
Bremond.....	467 feet.
Headville.....	470 feet.



The drainage areas are unequally divided into an eastern, or Navasota river basin, and a western, or Brazos river basin, of which the Brazos is the larger. The divide is formed by a narrow, irregular strip of higher land, not more than two miles wide at its greatest breadth, and frequently cut almost through by the headwaters of the various creeks. In places this divide is occupied by small prairies, from which the water drains indiscriminately towards either of the basins. The ridge, if it may be called such, extends in a general direction nearly north and south from near the southwest corner of Limestone county to the old San Antonio road a few miles west of Wheelock.

The eastern section is drained by the Navasota river and its tributary creeks, viz., Steele's; Red Oak; Duck, with its tributaries Stone Coal branch and Mineral creek; Camp, and the two Cedars. With the exception of Welch's bayou on the John and Joseph Welch leagues, no streams flow into the Brazos river proper, and the whole of the drainage of the western side of the county is collected from the different creeks by the Little Brazos. The creeks tributary to this stream are Walnut, with its subsidiary streams Birch, Middle, and South Walnuts; Sandy, Muddy, Pin Oak, Spring, and Campbell creeks, with Peach and Elm as branches of the last named.

With the exception of Duck and Big Cedar creeks on the east and south, and Walnut, Muddy, and Pin Oak on the west, the creeks of the county are all comparatively small, and dry throughout the greater portion of the year. These larger creeks maintain considerable streams of water at all times, except during a small part of the dryest season, and even then water can be found in large pools at different places in the creek beds.

The Little Brazos river marks the eastern extension of the bottom lands belonging to the Brazos drainage, and itself maintains a peculiar relation to the main river, in so far that for a distance of over forty miles it pursues an almost parallel course, from the northern side of Robertson county southward to its junction with the larger stream in Brazos county, about ten miles south of the line. The two channels are scarcely more than two miles apart through the whole of this distance, and nowhere do any streams intervene. The eastern bank of the Little Brazos is formed of a series of small bluffs, from twenty to twenty-five feet in height, which at places approach the river, and at others recede for one or two miles, but in either case are usually quite steep, and show more or less the general structure of the country to the east.

## GENERAL GEOLOGY.

The geological section of the county shows great stretches of recent alluvial deposits extending along the rivers and covering an area along the Brazos from two to four miles in width. Small patches of quaternary sands and gravels are found overlying the higher lands among the ridges. In the south and southeast the greensands and marls of the Moseley ferry and Wheelock sections predominate, and in the central and northern areas the Eocene lignitic and basal beds constitute the characteristic strata.

The general section shows the following approximate thickness of the several deposits:

Recent: River alluvium, found in the flood plains of the rivers and creeks and some of the second bottom lands.....	30 to 50 feet.
Quaternary: Gray and brown sands, brown conglomeritic sandstones and siliceous gravel, found along the ridges in the central portion of the county, and also underlying the river alluvium of the Brazos valley.....	20 to 50 feet.
Tertiary: Altered glauconitic sandstones, brown and green fossiliferous sands, green, blue, and dark gray fossiliferous clays, dark gray laminated sands and clays, with thin deposits of calcareous and fossiliferous sandstones and brown coals, and a basal series of dark gray and green fossiliferous sands and clays, with fossiliferous calcareous bands and nodules.....	1400 feet.

## RECENT.

A considerable extent of Recent deposits occurs along the western border of the county, comprising the region lying between the two rivers, the Brazos and the Little Brazos, and occupying an area from two to four miles in width, extending from Brazos county on the south to Falls on the north. The structure of these deposits, where undisturbed, is to a great extent laminated. Deposits of brown clays and sands, in laminæ, having an irregular thickness and no perceptible dip, form the great bulk of these beds. In close proximity to the Brazos river the clays are scarcely represented, and the alluvium is made up chiefly of brown river silts or fine sands, having occasional small pockets or thin sheets of a coarse sand or fine gravel.

The structure can best be seen in the sections obtainable at various places along the Brazos river. A section seen on the river six miles southwest of Calvert shows:

1. Brown sandy soil.....	1 to 2 feet.
2. Old humus, showing thin seams of brown sand interlaminated with the black soil.....	$\frac{1}{2}$ to 1 foot.

3. Brown sand.....	2 to 4 feet.
4. Thin strata of humus, interlaminated with yellowish brown sand.....	5 feet.
5. Black clayey humus.....	1 foot.
6. Brown sand.....	10 feet.

At the Port Sullivan bridge another section shows:

1. Brown soil.....	1 foot.
2. Dark humus.....	1 foot.
3. Brown sand.....	3 feet.
4. Dark humus, with interstratified or interlaminated deposits of brown sand.....	8 feet.
5. Dark brown sand.....	6 feet.
6. Black clay.....	10 feet.
7. Dark blue clay, weathering yellow, containing great quantities of limy concretions, to water.....	6 feet.

Nos. 6 and 7 of this section do not appear to belong to the Recent deposits, but to the upper or middle Quaternary.

On the eastern side of this alluvial tract, a section near Dr. George McLendon's gin shows the brown river sand overlying Quaternary gravel and lignitic deposits:

1. Brown sandy river drift and soil.....	10 to 15 feet.
2. Ferruginous and quartz gravel.....	2 feet.
3. Thin bed of brown sandstone, containing plant remains.....	1½ feet.
4. Gray laminated lignitic sand.....	5 feet.
5. Brown coal.....	8 feet.

From these sections it would appear that the whole of the area is subject to overflow, and that these overflows are very intermittent and frequently at such long intervals apart as to admit of the formation of a surface soil in many places between the successive flooding.

These deposits nowhere exceed 35 or 40 feet in thickness, and the fauna is altogether of shells of species now living in the Brazos valley.

#### QUATERNARY.

The Quaternary deposits occupy but a limited area, and admit of a division into two periods—a lower and an upper. The lower division is composed of gray and brown sands, brown conglomeritic sandstones, ferruginous and siliceous conglomerates, and ferruginous and quartzitic gravels. This division is found along the ridges in the central portion of the county, and underlying the upper clay division throughout the Brazos river valley. The second, or upper division, consists of a bluish green clay, weathering yellow, with numerous limy concretions and containing recent shells, some species not now known to be living in the Brazos valley, and several not known to be living in the State. This class of deposits occurs only in the valley of the Brazos river.



1. **LOWER DEPOSITS.**—The deposits belonging to this class occur chiefly in the higher regions of the southern, central, and southwestern portions of the county. They also occur as thin scattered gravelly sheets, of a few inches or less in thickness, in places in the north central and western areas. Deposits of brown sand and gravel occur at various places among the bluffs along the east side of the Little Brazos, and gravels and conglomerates belonging to these beds are also found underlying the alluvium and bluish clays of the upper division everywhere in the district between the Little Brazos and Brazos rivers.

Large quantities of gravel and brown sand occur in the neighborhood of Sutton. Eight and a half miles east of Hearne, on the Hearne and Wheelock road, a section of the highest portion of the ridge shows:

- |   |          |
|---|----------|
| 1. Red sand and ferruginous gravel..... | 4 feet.  |
| 2. Mottled red and gray sandy clay..... | 70 feet. |

Three miles nearer Hearne, on the same road, a section shows:

- |  |           |
|--|-----------|
| 1. Gray sandy soil.....                                      | 6 inches. |
| 2. Brown sand.....   | 5 feet.   |
| 3. Light gray almost white sand, with indurated laminae..... | 2 feet.   |
| 4. Irregular deposit of ferruginous sandstone.....           | 1½ feet.  |
| 5. Indurated laminated brown sand.....                       | 2 feet.   |
| 6. Pale pink sandy clay.....                                 | 12 feet.  |

Throughout the region embraced by these sections heavy deposits of gray sand and boulders of ferruginous conglomerate cover the whole area; and one and a half miles south of Hearne blocks of conglomerate, many measuring 10x8x5 feet, made up of brown sand and siliceous pebbles cemented together by a ferruginous matrix, form a ridge extending southward for over a mile. In the neighborhood of Hearne the conglomerate gives place to a soft brown colored sandstone containing streaks or small pockets of coarse sand or fine gravelly conglomerate. The same grade of sandstone is also found stretching along the south bank of Muddy creek from the Denver James headright eastward. A section on this headright shows:

- |  |             |
|--|-------------|
| 1. Gravel.....   | Scattering. |
| 2. Conglomerate.....   | 2 feet.     |
| 3. Ferruginous sandstone, with pockets or streaks of conglomerate..... | 4 feet.     |
| 4. Red sand.....   | 3 feet.     |
| 5. Yellowish gray sand, with streaks and pockets of white sand....     | 40 feet.    |

This sandstone ridge, with its capping of gravel, extends in a nearly north direction to the west side of Little Muddy creek, on the south side of the Henry Reed league, where the sandstones disappear under a heavy deposit of loose gray sand.

South of the International and Great Northern Railway, in the neighborhood of Hearne, another ridge begins and extends northeast to Frank-

lin. In going eastward along this ridge conglomerate and sandstones occur on the crests and sides of the hills, and in the vicinity of Franklin they are extensively developed. The country to the south of the town, surrounding and forming Racetrack prairie, is occupied by a series of small rounded hills or "knobs" covered with blocks of ferruginous conglomerate. These conglomerates, with their associated brown sands, also appear close to the town, three miles northwest of Franklin, on the Calvert road, and throughout the surrounding area as far west as Little Muddy creek. The country is broken and irregular, and covered with a deep bed of loose gray sand, through and among which boulders of ferruginous sandstones and conglomerates appear plentifully. A section on the east side of Little Muddy creek shows:

1. Brown ferruginous sands and gravel..... 2 feet.
2. Brown laminated sands and soft sandstones ..... 1½ feet.
3. Gray laminated micaceous sands..... 8 feet.

The gravels of this age spread over the lower lands throughout the central and northern portions of the county, but generally occur only in thin sheets of not more than a few inches in thickness, and accompanied with deposits of brown and yellow sand. A section near mile post 124 on the Houston and Texas Central Railway shows:

1. Brown sand..... ½ to 3 feet.
2. Fine gravel, with streaks of coarser gravel and occasional small nodules, changing to a coarse brown sand with streaks of fine gravel near the bottom ..... 5 to 7 feet.
3. Light blue sand, visible ..... ½ to 1 foot.

Near mile post 134, on the same road, another section shows a series of brown sands and gravels as follows:

1. Thin stratum of brown sand and gravel..... ½ foot.
2. Light brown sand. (This bed thickens toward the south, and replaces a brown gravelly sand 400 feet from the south end of the cutting)..... 1 to 4 feet.
3. Brown gravelly sand, 8 feet thick at the north end and thinning out southward..... 1 to 8 feet.
4. Gravel. Wedge shaped deposit, heaviest at south end, lying near center of the cutting, and 50 feet in length..... ½ to 2 feet.
5. Brown gravelly sand, same as No. 3..... 0 to 3 feet.

These sections may be duplicated in many other portions of the county.

Gravels and conglomerates occur at many places in the bluffs along the banks of the Brazos river. They underlie the brown river alluvium and bluish limy clays of the succeeding deposits. The conglomerates are mostly siliceous, formed of pebbles of quartz, silicified wood, and limestone, with great quantities of nodules of a white calcareous clay, cemented together by a silicate of lime. They contain numbers of worn

Cretaceous shells, shark teeth, and occasional vertebrate remains, mostly of the *Equus* family. A section at Curley shoals, six miles west of Calvert, shows:

1. Brown river silt and sand.....	5 to 10 feet.
2. Conglomerate .....	4 to 6 feet.
3. Pale blue clay.....	1 foot.
4. Micaceous blue sand.....	3 feet.
5. Gray calcareous sandstone.....	4 feet.
6. Grayish blue sand.....	2 feet.
7. Gray sandstone, over.....	2 feet.

At this point the shoals are formed by a heavy ledge of gray sandstone (No. 7 of section). The conglomerate is made up chiefly of siliceous pebbles and blocks of limestone from the Cretaceous beds found farther up the river; occasional nodules of iron, and great quantities of worn Cretaceous fossils of the *Gryphæa vesicularis* type, the whole cemented into a solid mass by a silicate of lime. Fragments of the tibia of a horse were found imbedded in one of the larger blocks, and considerable quantities of nodules of calcareous clay are scattered through the whole mass.

2. UPPER DIVISION.—The upper division of the Quaternary deposits was only observed in the Brazos river valley, and comprises a series of deposits of bluish green clay, weathering yellow, with numerous limy concretions containing shells of recent species and species not now known to be living in the Brazos drainage area, and several, such as the *Limnea reflexa*, Say, and *Pomatiopsis lapidaria*, Say, which are not known to be living in the State. The latter occurs in the Post Pliocene of the Mississippi river bluffs.\*

The deposits belonging to this division have been noticed at several localities in the Brazos river valley, from the south side of Brazos county northward to near the Falls county line. They have the peculiarity of appearing in small embayments, on both sides of the river, and generally in alternate positions, indicating that at the time of their deposition the river, although approximating its present position, was flowing through a channel widely differing in its curves. These clays appear overlying the gravels in every case where the two have been found associated, whether cut through by wells or in the river bluffs where the channel has been cut deep enough to expose the underlying deposits. The position of these deposits is seen in the following section of the bluff along the east side of the Brazos at Port Sullivan shoals:

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\* Of one of these shells, Mr. J. A. Singley, to whom they were referred, says the *Pomatiopsis lapidaria*, Say, has a distribution from Georgia to New York, Missouri to Michigan, Post Pliocene of the Mississippi river bluffs. No recent record in Texas or adjoining States, and this I think establishes the fact that the clay from which it is derived is Quaternary.



1. Brown sand ..... 1 foot.
2. Laminated chocolate colored and yellow stratified sandy clay,  
with humus at base ..... 2 feet.
3. Dark brown or chocolate colored sandy clay ..... 8 to 10 feet.
4. Dark bluish gray sandy clay, weathering yellow and containing  
fragments of bone and shells of recent species and others .... 10 feet.
5. Indurations of sand and soft sandstones in the form of boulders. 1 to 2 feet.
6. Gravel..... 1 foot.
7. Laminated dark greenish black sand to water..... 2 feet.

The bone fragments found in No. 4 are mostly in such a comminuted condition as to be unrecognizable. In one instance, however, we obtained a lower jaw and teeth of a horse almost entire.

## TERTIARY.

The Tertiary deposits of Robertson county belong altogether to the Eocene division of that period, and represent three distinct stages of that group, and may be divided as follows:

Series.	Division.	Thick- ness.	Characteristic Strata.
Eocene.	Marine.....	600	Fossiliferous greensands, marls, and fossiliferous clays.
	Lignitic ...	550	Lignites and brown coals.
	Basal beds..	250	Fossiliferous clays and sands and limestones: calcareous sandstones.

Areally, these deposits cover the whole of the county. The basal beds occupy a small territory in the northwest corner, the lignitic deposits stretch across the county, in the form of a wide band from eight to twelve miles in width, and the upper or marine fossiliferous sands cover about one-half of the county. The dip of the beds is in a general direction of south 20 to 30 degrees east, and at varying angles, ranging from 0 to 1 degree.

**BASAL BEDS.**—The deposits assigned to this division occupy but a very small areal extent in the northwestern portion of the county. The territory is generally level, and so covered with surface deposits of gray sand and river alluvium that few exposures of the underlying beds can be seen anywhere.

These beds differ in lithological character from the clays at Wills Point. In this locality the deposits are not so regularly laminated, and contain a much greater proportion of sand and sandy strata, and are also more fossiliferous. The basal beds as represented at Wills Point consist of yellow laminated clays, with thin partings of yellow sand, containing occasional boulders of siliceous limestone; massive bedded clay, showing no signs of lamination; and dark blue laminated much jointed clay, with thin sandy

partings, containing occasional small bivalve shells, and showing a heavy bed of white limestone containing great quantities of fossil casts.\* The basal beds as represented in Robertson county comprise a series of thinly stratified yellowish gray sands, and grayish blue laminated clays and sands, with broken strata of grayish blue fossiliferous siliceous limestone, and occasional rounded and flattened boulders of gray calcareous sandstone. The blue siliceous fossiliferous limestone possibly represents the same horizon as the white limestone found at Elmo and Rocky Cedar and Kemp, in Kaufman county, and at Tehuacana, in Limestone county. The dip of the beds is toward the southeast, and very gentle and undulating. In places they present long stretches of almost horizontal strata, suddenly terminating in a downward flexing of the beds, which, however, continues for only a short distance, when the practically horizontal bedding is again resumed. The following sections seen on the western side of the Brazos river will show the general structure of these deposits:

I. Section on the northeast corner of the Byrum Wickson league, Milam county:

1. River alluvium.....	4 feet.
2. Conglomerate.....	2 feet.
3. Coarse conglomerate, with boulders .....	1½ to 2 feet.
4. Thinly stratified yellowish gray clay, sand, and blue clay, with occasional rounded boulders of calcareous sandstone.....	10 feet.
5. Blue laminated clay, fossiliferous.....	4 feet.
6. Thin bed of nodules and hard fossiliferous limestone.....	1 foot.
7. Thinly laminated yellowish gray clay and sand.....	3 feet.
8. Bluish gray sand.....	1 foot.
9. Thinly laminated dark blue clay and sand.....	6 feet.
10. Dark blue laminated and fossiliferous clay.....	2 feet.

II. Section on C. Cribbs league, between two and three miles north of No. 1:

1. Surface soil, brown sand and gravel .....	2 feet.
2. Yellow clay... ..	4 feet.
3. Ledge of fossiliferous siliceous limestone.....	2 feet.
4. Yellow clay, same as No. 2 .....	5 feet.
5. Same as No. 3 .....	2 feet.
6. Dark blue thinly stratified clay, showing lines of lamination on weathering, and jointed.....	30 to 35 feet.

The dip is very gentle towards the southeast, and in places along the bluff shows the undulations referred to.

Going still further north into Falls county, the base of these beds is seen in contact with the underlying Cretaceous deposits in section No. III, on the southeast corner of the Josiah Hogan league:

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\*Penrose, First Annual Report Geol. Survey of Texas, pp. 19-21. Kennedy, Third Annual Report Geol. Survey of Texas, pp. 48-49.

1. River alluvium.....	4 feet.
2. Gravel .....	1 foot.
3. Blue clay and sand, breaking into nodules and conchoidal pieces, weathering to a grayish yellow, and containing in the upper half <i>Calyptrophorus velatus</i> , Conrad, <i>Cucullæa macrodonta</i> , Whitfield, <i>Ostrea pulaskiensis</i> , Harris, and others; and <i>Cardita alticostata</i> , Conrad, <i>Pleurotoma</i> , sp., <i>Yoldia</i> , sp., and <i>Crassatella</i> , sp., in lower two and a half feet*.....	5 feet.
4. Transitional blue clay.....	1 foot.
5. Massive blue clay, with baculites and other fossils.....	14 feet.

LIGNITIC BEDS.—Succeeding the basal beds comes a series of interlaminated, interstratified, and massive dark gray and dark blue sands and lignites, interstratified with beds of dark bluish gray calcareous and siliceous sandstones and brown fossiliferous sandstones, the blue and bluish gray sands predominating. In the eastern portion of the county a small section on Mineral creek shows an exposure of the blue and red thinly stratified or laminated sands and sandy clays belonging to the Queen City beds of this series. In the west these beds do not appear in any of the sections seen.

The beds belonging to this division form a continuation of the great lignitic beds lying near the base of the Eocene in this State, and stretching from the Arkansas and Louisiana line southwestward across Texas. They enter Robertson county from Limestone on the north and Leon on the east, and extend in a general south by west direction to the Brazos river on the western side.

The lignitic sands, sandstones, and clays, with their associated beds of brown coal and lignite, cover an area approximating 340 square miles, or one-third of the entire area of the county.

A line drawn from near the mouth of Pond creek in a northerly direction through Hammond, Wooten Wells, and Bremond, or almost parallel to the line of the Houston and Texas Central Railway, will approximate the northern boundary of these beds. Toward the south they pass under the succeeding beds of the Marine Eocene along the south side of Muddy creek, and on Mineral creek about four miles east of Franklin. Along the southern margin few exposures of the contact can be seen, owing to the whole of that area being more or less covered by Quaternary brown sands and gravels. This boundary may be drawn approximately from the Navasota river, near the crossing of the International and Great Northern Railway, westward to Mineral creek, and thence to Owensville; thence in a general west by south course to Muddy creek, and then along the north side of that stream to the Brazos river.

The region underlaid by these beds is generally level or slightly rolling, and is more or less covered with a scanty growth of timber. Numerous

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\* Determinations by G. D. Harris.



small prairies, such as Tidwell, Beck, Head, Heard, Bald, and others of smaller extent, occur throughout the northern and central portions of the region. Mesquite prairies cover the greater portion of the western side of the area from Bremond southward.

Several large creeks traverse the country underlaid by these deposits, having generally broad, shallow bottoms, with few or no exposures showing the deeper or underlying deposits.

The Brazos river crosses this region in a general course from northwest to southeast, and in many places the banks form steep, almost precipitous, bluffs. In these the structure and general sequence of the beds forming the lignitic group can best be seen and studied.

Beginning at the south side of the field, the highest beds seen are those exposed at the base of the section shown near Bee shoals. The next exposure of any value is that at Calvert Bluff, on the Jesse Webb league.

At this place the bank of the river forms a bluff extending along the east side for 700 or 800 yards, and shows a section of:

1. Brown loamy clay .....	4 feet.
2. Light brown sand .....	7 feet.
3. Brown sand and gravel.....	1½ feet.
4. Gray sand.....	0 to 3 feet.
5. Brown coal .....	12 feet.
6. Dark blue clay .....	3 feet.
7. Brown coal .....	3 feet.
8. Dark blue clay .....	6 feet.
9. Brown coal .....	3 to 4 feet.
10. Dark grayish blue sand.....	15 feet.
11. Thin stratum of calcareous sandstone .....	½ foot.
12. Dark gray sand, similar to No. 10.....	2 feet.
13. Brown coal, poor quality .....	2 to 6 inches.
14. Dark gray sand, similar to No. 10.....	8 feet.
15. Gray calcareous sandstone.....	1 foot.
16. Dark bluish gray sand, with quantities of iron pyrites .....	8 feet.
17. Boulders of clay ironstone and gray calcareous sandstones, with nodules of iron and thin seams of ferruginous sandstones with fossil leaves .....	2 feet.
18. Gray sandstone, weathered and eroded into an irregular capping covering No. 19.....	1½ feet.
19. Laminated bluish gray sand to water at Herndon shoals.....	2 feet.

This section extends to within a mile of the upper portion of the next section at Bee shoals, and between the two a section on the west or Milam county side of the river shows:

1. Brown soil.....	1 foot.
2. Yellow sandy clay.....	12 feet.
3. Pale blue sandy clay, with limy concretions.....	8 feet.
4. Brown coal .....	3 feet.
5. Iron ore.....	1 foot.

- |  |         |
|--|---------|
| 6. Dark blue clay .....  | 2 feet. |
| 7. Brown coal at foot of Bee shoals, extending 20 feet into the river... | 4 feet. |

This No. 7 is apparently the same as the thin seam of lignite, No. 5 of the Bee shoals section, as all the lignites in this region show a tendency to thicken towards the south.

Section at Bee shoals, close to Black's bridge across the Brazos river, on the Calvert and Cameron road:

- |  |                |
|--|----------------|
| 1. Brown loam .....  | 10 feet.       |
| 2. Gravel .....  | 1 foot.        |
| 3. Gray sand.....  | 5 feet.        |
| 4. Black or dark blue clay, jointed and broken into cuboidal blocks .....      | 1 foot.        |
| 5. Broken seams of brown coal, running out 300 feet from foot of shoals.....   | 6 inches.      |
| 6. Black clay, similar to No. 4.....   | 5 feet.        |
| 7. Pavement of sandstone, brown on outside and dark bluish gray on inside..... | 1½ to 6 feet.  |
| 8. Clay similar to No. 4 to water, running 100 feet up the river               | 4 feet.        |
| 9. Thin stratum of gray calcareous sandstone.....                              | 4 to 6 inches. |
| 10. Gray sand, laminated, and containing thin layers of dark clay .....        | 10 feet.       |
| 11. Bed of rounded, water-worn boulders, containing streaks of calcite .....   | 1 foot.        |
| 12. Gray sand, with pyrites .....  | 0 to 5 feet.   |

These shoals are about 400 feet long, and the beds dip southeast at an angle of 1 to 3 degrees.

Half a mile further north the river crosses another series of shoals known as Cannon Ball shoals. At this place the bluff overlooking the river shows a series of gray sands, in beds from 5 to 15 feet in thickness, and interstratified with thin seams of calcareous sandstones, from six inches to one foot thick.

Going east from the river, such sections as can be obtained from cuttings and well borings show practically the same succession of beds as are exposed in the bluffs along the river.

A well bored on the E. D. Peters plantation, five miles southwest of Calvert, and between the two rivers, shows the following section:

- |   |          |
|---|----------|
| 1. Grayish brown soil, subsoil.....   | 10 feet. |
| 2. Brown sand.....  | 10 feet. |
| 3. Gravel .....   | 22 feet. |
| 4. Bluish gray sand .....   | 4 feet.  |
| 5. Brown coal.....  | 5 feet.  |
| 6. Calcareous sandstone.....  | 1 foot.  |
| 7. Brown coal.....  | 4 feet.  |
| 8. Bluish gray sand, and seams of calcareous sandstone and clay, the sandstones in the strata of about 10 feet..... | 99 feet. |
| 9. Brown coal.....  | 4 feet.  |

10. Same as No. 8.....	61 feet.
11. Brown coal.....	18 feet.
12. Same as No. 8.....	50 feet.

Another well bored at Gibson's gin, near Calvert, shows a section of:

1. Surface soil and gray and brown sand.....	25 feet.
2. Alternate strata of blue clay and calcareous sandstone.....	42 feet.
3. Brown coal.....	2 feet.
4. Bluish gray sand, blue clays and calcareous sandstones.....	46 feet.
5. Brown coal.....	1½ feet.
6. Bluish gray sand.....	23½ feet.
7. Brown coal.....	5 feet.
8. Blue sands and sandstones.....	55 feet.
9. Brown coal.....	2 feet.
10. Red clay.....	8 feet.
11. Bluish gray calcerous sandstones and blue clay.....	22 feet.
12. Brown coal.....	2 feet.
13. Blue sand.....	76 feet.
14. Brown coal.....	10 feet.
15. Blue sand, with thin seams of calcareous sandstone.....	265 feet.

Four miles north of Calvert, at Mr. W. Talbot's house, a well shows a section of:

1. Dark gray sandy soil and subsoil.....	2½ feet.
2. Gray joint clay.....	10 feet.
3. Gray sand.....	2 feet.
4. Joint clay and sand.....	8 feet.
5. Brown sand, with nodules of iron.....	10 feet.
6. Nodular iron ore.....	4 feet.

At Jericho church, about one and a half miles southwest of this place, a well 80 feet deep passes through blue sand with a thin seam of brown coal near the bottom.

On Beck's prairie, six miles north of Calvert, a section shown in a small creek gives:

1. Gray sandy soil.....	1 foot.
2. Mottled sand.....	4 feet.
3. Pale blue sand.....	2 feet.

On this prairie wells bored to the depth of 75 to 80 feet pass through three seams or beds of brown coal, and a section on Wilson's creek, near the center of the William Fullerton league, shows:

1. Brownish gray sand, with gravel and nodules of ferruginous sandstone, seen on hill near Mr. Wilson's house.....	50 feet.
2. Bluish sandy clay.....	4 feet.
3. Brown coal.....	4 to 6 feet.
4. Dark gray sand or clayey sand.....	6 to 7 feet.
5. Brown coal.....	3 feet.



In the Headville region the lignite deposits come close to the surface, and are exposed in many of the small creeks and washouts.

At Franklin a well 1200 feet deep shows a section of:

1. Red clay.....	72 feet.
2. Blue sandy clay and sandstones, interstratified.....	40 feet.
3. Gray sand and sandstones, interstratified.....	101 feet.
4. Quicksand, with water.....	2 feet.
5. Blue sands and sandstones, interstratified, sandstone strata about 2 feet thick, but not regular, and only occurring at wide intervals..	855 feet.
6. Blue sand, with water .....	1 foot.
7. Blue sand.....	137 feet.

## MARINE BEDS.

Lying to the southward, and succeeding the lignitic sands and clays of the last division, there is an extensive series of brown, yellow, green, and dark clays, sands, and marls. These constitute the division known as the Marine Eocene beds, and are a continuation of the great series of similar beds which pass from the east through Cherokee, Houston, and Leon counties, and extend across the Brazos river into Burleson and other counties lying west of Robertson, with a southern extension into Brazos county. They cover an area of approximately 450 square miles, and occupy the whole of the southern half of the county.

The southern border of the lignite group already described forms the northern border of the marine series.

The country occupied by the marine beds is broken and hilly, and very generally heavily timbered with blackjack, post oak, other oaks, and hickory, except in the southeastern portion, where extensive tracts of prairie and rolling country appear. Few creeks pass through the region, and these have steep-sided channels with narrow bottoms.

The general sequence and texture of the beds can best be seen in the following sections, extending from the base to the top of the series, as far as exposed in Robertson county.

A section at the International Railway bridge across the Brazos river shows:

1. Yellow sandy clay, with nodules of lime.....	20 feet.
2. Brown sandstone, interstratified with brown sand.....	4 to 6 feet.
3. Dark green, almost black, micaceous unfossiliferous sand.....	5 feet.
4. Thinly laminated dark green sand.....	6 feet.
5. Irregular belt of ferruginous sandstone.....	$\frac{1}{2}$ to 1 foot.
6. Dark green, almost black, sand, to water.....	3 feet.

On the south side of Muddy creek a ridge of altered glauconitic sandstone, containing nodules of iron ore, extends from near the Houston and Texas Central Railway westward for over half a mile, and ends in a

bluff about 50 feet high. It is nonfossiliferous so far as known. The next exposure occurs on Mineral creek, about four miles north of Franklin, where the section shows:

- |  |          |
|--|----------|
| 1. Gray surface sand .....   | 3 feet.  |
| 2. Dark gray sand and sandy clay, with gravel.....                     | 2½ feet. |
| 3. Gray sand.....  | 2 feet.  |
| 4. Brown sandstone, containing casts of fossils.....                   | 1 foot.  |
| 5. Thinly stratified or interlaminated blue and red sand and clay..... | 1 foot.  |

These sections occur at the base of the series, and with the exception of the thin bed at Mineral creek, are unfossiliferous.

Throughout the southern portion of the area the sections show a series of altered and unaltered greensands, sandy clays and sands, all highly fossiliferous. In the southwestern portion of the area the western continuation of these beds is shown at Moseley's ferry, and six miles north, at Collier's ferry, a bluff on the west or Burleson county side of the Brazos river shows:

- |   |                |
|---|----------------|
| 1. Brown sand.....  | 10 feet.       |
| 2. Indurated brown altered greensand.....                             | 8 inches.      |
| 3. Brownish green altered greensand, containing numerous fossils..... | 4 to 6 feet.   |
| 4. Grayish greensand, with fossils.....                               | 10 to 15 feet. |
| 5. Dark blue laminated fossiliferous clay .....                       | 6 to 8 feet.   |
| 6. Brown coal in river .....  | 4 feet.        |

This bluff is nearly 400 yards in length and over 30 feet high, and the bed dips slightly toward the southeast.

The fossils occurring in these beds belong mostly to the families of *Pecten* and *Ostrea*.

Six miles east, in the neighborhood of Benchley, the sections shown along the various creeks all show exposures of fossiliferous greensands, and at Sutton, four miles north, a cutting on the Houston and Texas Central Railway shows a section of:

- |   |           |
|---|-----------|
| 1. Brown sand and gravel .....          | 2 feet.   |
| 2. Altered fossiliferous sandstone..... | 8 inches. |
| 3. Fossiliferous greensand.....         | .....     |

Near the east side of the Robert Henry league, at the "Old Factory place," a section on Pin Oak creek shows:

- |   |            |
|---|------------|
| 1. Broken ferruginous material.....   | 1 foot.    |
| 2. Yellowish brown sandy clay .....   | 4 feet.    |
| 3. Brown altered greensand, containing oysters and other fossils, mostly broken ..... | 10 inches. |
| 4. Brown sand, with casts of fossils, to creek .....                                  | 10 feet.   |

Near the head of Campbell's creek, on the Stephen Gafford and James Dunn leagues, the western extension of the Wheelock prairie becomes

rolling and broken. This area presents a series of laminated sands and clays, with occasional beds of fossiliferous sandstone. A section of this prairie shows:

1. Black soil ..... 1 to 4 feet.
2. Brown sand, with limy streaks ..... 2 to 6 feet.
3. Brown ferruginous sandstone, with casts of fossils..... 2 feet.

Near Dunn's ranch a section of Campbell's creek shows:

1. Black soil ..... 2 to 4 feet.
2. Brown sand, with lime..... 4 to 8 feet.
3. Fossiliferous sandstone, containing oysters and *Cardita planicosta*, Lam..... 1 foot.
4. Brown fossiliferous sand..... 1 to 3 feet.
5. Black laminated fossiliferous clay..... 2 feet.
6. Indurated greensand, with corals and *Cardita planicosta* Lam., and other fossils..... 1 foot.
7. Fossiliferous laminated blue clay..... 10 feet.
8. Alternate strata of yellowish sand and blue clay, the clay strata 6 inches, and sand from 4 to 8 inches thick ..... 4 feet.
9. Brown sand, visible ..... 1½ feet.

Half a mile farther west a section on the same creek shows:

1. Surface yellowish brown sand ..... 10 feet.
2. Brown sand with fossils..... 2 feet.
3. Ferruginous sandstone, with fossils ..... ½ to 1 foot.
4. Fossiliferous greensand, visible..... 4 feet.

In the Wheelock region the brown prairie sands and loams cover the greater portion of the area. On the top of some of the higher ridges or knolls east of Cedar creek grayish brown sand, with occasional patches of a soft brown conglomerate, occurs in considerable quantities. The section in this portion of the prairie shows:

1. Black to brown soil ..... 1 to 5 feet.
2. Brown sand, with *Spirorbis leptostoma*, Swain, and casts of fossils and streaks of lime..... 2 to 6 feet.
3. Blue laminated clay, irregularly deposited in pockets, from.. 1 to 10 feet.
4. Thin stratum of fossiliferous sandstone, containing great numbers of *Plicatula filamentosa*, Conrad. .... 6 to 10 inches.
5. Brown sand..... 1 to 4 feet.

Along Cedar creek, from the Madisonville road bridge southward, exposures of brown and green fossiliferous sands occur for a considerable distance. Half a mile south of the bridge a section shows:

1. Brown soil of overflow land..... 5 to 15 feet.
2. Brown altered greensand, containing numerous fossils ..... 4 feet.
3. Ferruginous fossiliferous sandstone..... 1 foot.
4. Dark grayish green fossiliferous sand..... 4 feet.



Going down the creek, another section, 100 yards farther south, shows:

1. Brown sand ..... 5 feet.
2. Laminated blue and pink clays..... 4 to 6 feet.
3. Dark green fossiliferous sand ..... 4 feet.

Five hundred yards further south another section on the same creek shows:

1. Brown sand, bottom land..... 10 feet.
2. Dark brown and purple brown laminated sand and clay, with fossils  
in the sand, to creek bed..... 2 feet.

Throughout this region fossils occur in the different wells bored or dug to the depth of 30 to 50 feet.

## ECONOMIC GEOLOGY.

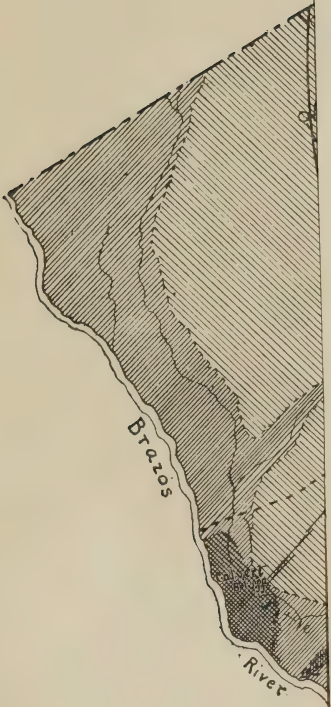
### SOILS.

The soils in Robertson county may all be considered as fit for cultivation, although poor in many portions. They belong to the two great divisions—the alluvial or sedimentary, and the residuary or sedentary, of which the alluvial, although ranking only as second in point of extent, is the more important—and may be subdivided as follows:

First.—Alluvial, constituting the soils found throughout the Brazos river valley, on the western side of the county, and the bottom lands of the Navasota river, on the east, and connected with several of the larger creeks.







These lands are estimated by Loughridge to include about one-fourth of all the soils under cultivation in the county. They lie principally in the area between the two Brazos rivers. The soil is an alluvial loam from two to ten feet deep, varying from a gray sandy to a red and black waxey, and the subsoil is frequently sandy and sometimes clayey, of a red brown color, and extends to a depth of over 30 feet, where it rests upon a bed of white rounded pebbles of quartz and other gravel. Where these soils are sandy the tillage is easy, but when the soil is clayey or waxey, difficult in wet seasons. They are well drained and equally well adapted to cotton and corn.

These soils belong to the Brazos river lands, which are considered the best and most valuable in the State. An analysis from Dr. McLendon's farm shows:







-  Overflow area.
-  Brown coal.
-  Northern border of greensands.
-  Eocene.
-  Railroads.
-  County roads.

0 1 2 3 4 5 Miles

MAP OF ROBERTSON COUNTY.



	Soil.	Subsoil.
Insoluble in hydrochloric acid.....	54.06	51.83
Soluble silica.....	11.39—65.45	12.13—63.96
Potash.....	0.307	0.278
Soda.....	0.60	0.73
Lime.....	8.07	8.67
Magnesia.....	0.78	1.20
Oxide of manganese.....	0.10	0.66
Ferric oxide.....	3.47	3.04
Alumina.....	5.56	6.13
Phosphoric acid.....	0.088	0.082
Sulphuric acid.....	trace	trace
Carbonic acid.....	7.26	7.74
Humus.....	1.63	1.29
Water.....	6.04	6.27
	<hr/> 99.355	<hr/> 100.05

A mechanical analysis shows the physical condition to be:

	Soil		Subsoil	
	Fixed.	Volatile.	Fixed.	Volatile.
Stones and sticks.....				
Coarse sand.....	2.88	0.56	0.18	0.13
Medium sand.....	15.68	1.69	25.20	1.58
Fine sand.....	46.38	2.38	16.08	5.64
Fine soil.....	20.07	10.36	43.16	8.03
	<hr/> 85.01	<hr/> 14.99	<hr/> 84.62	<hr/> 15.38
	100		100	
Capacity for water.....	56.8 per cent.		62.2 per cent.	

Analyses by Dr. W. H. Melville.

Second.—Upland soils. These cover the greater portion of the county, and are chiefly of a grayish sandy nature in the northern part, except in the prairie regions. They are from five to twelve inches in depth, and overly a red or yellowish clay subsoil. The prairies have a stiff loamy soil, except near the timber, where they become sandy.

These soils rapidly deteriorate under prolonged cultivation, and are said to lose about one-fifth of their productive power in ten years. They are early and well drained in places, and easily cultivated. An analysis gives the following composition:\*

	Soil.	Subsoil.
Insoluble in hydrochloric acid.....	89.23	90.20
Soluble silica.....	3.81	3.12
Phosphoric acid.....	0.006	0.008
Potash.....	0.032	0.044
Soda.....	0.232	0.20

\* William Fullerton league.

\*8—Geol.

	Soil.	Subsoil.
Lime.....	0.20	0.24
Carbonic acid.....	0.11	0.09
Magnesia.....	0.12	0.05
Ferric oxide.....	0.98	1.15
Alumina.....	1.73	2.27
Manganese oxide.....	0.04	0.19
Sulphuric acid.....	trace	trace
Humus.....	1.67	0.73
Water.....	1.87	1.74
	100.03	100.03

Their physical condition is shown by the following mechanical analysis:

	Soil		Subsoil	
	Fixed.	Volatile.	Fixed.	Volatile.
Stones and sticks.....	1.36	0.26	2.19	0.26
Coarse sand.....	10.46	0.32	24.58	0.16
Medium sand.....	48.54	0.52	48.84	0.50
Fine sand.....	20.35	0.85	19.11	0.60
Fine soil.....	15.51	1.83	3.00	0.76
	96.22	3.78	97.72	2.28
	100		100	
Capacity for water.....	39.9 per cent.		35.8 per cent.	

Analyses by Dr. W. H. Melville.

The soils of the higher grounds in the central areas are light gray sand, and in many places little else than a deep white sand, rendering many of the roads through the region almost impassable at many portions of the year. They are usually covered with a heavy growth of sand oak, post oak, and hickory, but may be considered as almost worthless for the purposes of cultivation.

In the southern and southeastern portions of the county the extensive prairies are covered with a dark brown or black soil, changing to yellowish brown color in places, very irregular in depth, and in many places a brown ferruginous sandstone comes up to within a few inches of the surface. Where of sufficient depth for tillage this soil is considered good. This area is not much under cultivation, and is used chiefly for stock purposes.

#### BUILDING STONES.

The building stones of Robertson county are wholly of brown sandstone, and occur in many locations along the ridges extending across the county from the Houston and Texas Central Railway eastward. They are rather coarse-grained, and contain frequent streaks or pockets of coarse sand or fine gravel in the form of a conglomerate.

The sandstones found along the top of the ridge on the Denver Jones headright form a bed from two to four feet in thickness, and have been quarried for railway purposes, having been used as piers and abutments of bridges on the line of the Houston and Texas Central Railway.

Near Hearne, another deposit of the same grade of sandstone has been quarried for building purposes. This deposit is small, and covers the top of several small rounded hills along the east side of the town.

In the neighborhood of Franklin the hills near the town and surrounding Racetrack prairie contain soft brown sandstones, which may be utilized for building purposes. They also occur to the west of the town, and at several other places in the central portion of the county.

#### CLAYS.

Throughout the greater portion of Robertson county good brick clays or earths are plentiful, but with the exception of one yard at Calvert and two at Hearne, no permanent brick making is carried on, and even the yard at Calvert has been idle for some time. In only one of the yards at Hearne is work carried on continuously and systematically. This yard, that of Mr. Robb, employs about twenty men during the busy season, and during 1892 the total output was 1,250,000, at a value of \$12,500. The bricks are hand-made and dried under cover. In burning, bituminous coal is chiefly used. The smaller Elliot yard turned out 500,000.

In the northeastern portion of the county deposits of clay suitable for the manufacture of the finer grades of earthenware exist. Clays closely approximating the Kosse fire clays also exist in this region. These clays were examined by Prof. Streeruwitz a number of years ago and considered a fine grade of fire clay. The extent and locations of these deposits can not as yet be given, but will appear in the report on the clays of the State now in course of preparation.

#### BROWN COAL.

The great East Texas brown coal belt extends through Robertson county from the eastern boundary in a west by south or nearly south-westerly direction to the Brazos river, and comprises an area of almost one-third of the entire county. The northern boundary of this lignitic area is co-existent with, and extends across, the northern line of the county, and the southern limit of the field lies along a line extending from the Navasota river westward to Owensville, and then along the northern bank of Muddy creek to the Brazos river, near the mouth of Little river, in Milam county. This region embraces Tidwell, Beck,



Head, Heard; and Bald, together with a series of other smaller prairies lying across the center and in the northern portion of the county.

Throughout the whole of this area, with perhaps a portion of the extreme northwestern corner of the county, brown coal occurs in greater or less quantities and at various depths, embracing eleven seams lying at depths ranging from 15 to 320 feet, and ranging in thickness from 1½ to 21 feet, of which six seams contain enough to allow them to be worked. These workable deposits fall into two divisions of three seams each, differing chiefly on account of the depth and accessibility. The first division comprises the following:

Location.	Depth, in feet.	Thickness of brown coal, in feet.	How obtainable.
1. Calvert bluff.....	15	12	Stripping.
2. E. D. Peters' plantation.....	46	5	Shaft.
3. Beck prairie.....	62	7	Shaft.

These brown coals are all available at the localities given. No. 1 can also be reached without difficulty at Dr. George McLendon's farm and other points on the Little Brazos river.

In the second division, although three localities are given, it is more than probable that two of them (Nos. 1 and 2) belong to the same seam.

Location.	Depth, in feet.	Thickness of brown coal, in feet.	How obtainable.
1. Jesse Webb league.....	220	21	Shaft.
2. E. D. Peters' plantation.....	240	18	Shaft.
3. Gibson's well at Calvert.....	320	10	Shaft.

Mines operating these seams will probably all require pumping to keep them dry, and can not be worked profitably under the present condition of the trade.

In the northwestern portion of the county the lignitic beds are represented merely by thin seams of lignitic clay and laminæ of lignite of no value whatever.

The best exposures of brown coal are seen on the Brazos river at Calvert Bluff, where three seams of 12 feet, 3 feet, and 3 feet, aggregating 18 feet, are exposed near the center of the bluff. The deposits shown here continue for a distance of nearly a mile up and down the river.

Several exposures occur in the banks of the Little Brazos, on the Joseph and Jesse Webb leagues. In this region the most important opening is that on Dr. George McLendon's farm, where the brown coal shows a thickness of 8 feet overlaid by 23 feet of brown and gray sand and sandstones. A similar exposure also occurs a short distance down the same river.

Near the north side of the John Fisher headright a shaft 60 feet deep cuts a brown coal deposit six feet in thickness, and on Wilson creek, near

the center of the William Fullerton league, another shaft passed through three seams of brown coal at 55, 70, and 80 feet. In this region the brown coal is also exposed in the bank of the creek.

In the prairie regions brown coal appears near the surface at various localities, and is exposed in several of the creeks and washouts. At Headville, on the C. C. Seal headright, the exposed brown coal is from 4 to 6 feet thick, and the deposit on Wilson creek is from 4 to 6 feet. As a general rule, however, the surface exposures are thin and of no economic value. Thus the exposure on the Captain Orvis farm, on the southwest corner of the George Robertson league, is not more than two feet of broken crumbly lignite. Another outcrop of a similar nature occurs in a small creek near the center of the Joseph Fisher league. The lignite at this locality is broken and crumbly at the south end, or toward the head of the creek, but as the bed extends northward it becomes dark brown in color and assumes a woody or peaty structure, having the characteristic odor of the latter when freshly broken. This lignite also contains numerous fragments of leaves. The heavier deposits found throughout the prairie regions all lie at depths of 45 feet and over.

Brown coal also occurs in the neighborhood of Owensville, where it is overlaid by a red sandstone. At Hearne the brown coal is found at a depth of 408 feet, while in the neighborhood of Wheelock, and at several localities between that place and Franklin, wells 50 to 60 feet deep frequently cut through beds.

In the valley of the Brazos, and in the region lying between the two rivers, brown coal occurs in well borings generally at depths of 30 to 400 feet. This is, however, of a poor quality and in no great quantity.

Desultory mining and prospecting work have been carried on at various times for a number of years. A shaft 65 feet deep was dug several years ago about three miles north of Calvert, on Mr. John Walker's land. Another shaft, over 100 feet in depth, was dug on Beck's prairie by the Texas Coal Company, and several smaller shafts have also been made in different portions of the county by several parties.

Brown coal has been mined and shipped at different times from Calvert Bluff, and a quantity estimated at 300 tons has been obtained from a surface opening at Dr. George McLendon's place on the Little Brazos.

The neglect or abandonment of these operations are not due to any peculiar defect within the material itself, nor to any serious obstacle in the way of mining, as the workable beds show as good facilities as many now mined, but is due altogether to a lack of facilities for transportation. The beds lie mostly at too great distances from the railways traversing the county, and the cost of teaming is much greater than the prices obtainable for this class of fuel will stand.

## TIMBER.

Robertson county is fairly well timbered. Of the 869 square miles, comprising the total area of the county, probably 650, or nearly four-fifths of the whole, are more or less covered with timber of fairly good growth. Throughout the higher lands, post oak, red oak, blackjack oak, hickory, and elm form the prevailing timber, and the bottom lands, where not in cultivation, are covered with pin oak, walnut, pecan, cedar, ash, and cottonwood, with several varieties of smaller trees. Along the western side of the county a great area is covered with mesquite brush.

## WATER SUPPLY.

Robertson county may be considered as fairly well watered. The Navasota river, with its large tributaries, such as Duck and Big Cedar creeks, on the east and south, and the Brazos and Little Brazos rivers, with Walnut, Muddy, Spring, and Campbell's creeks on the west, contain a supply ample for stock and other purposes throughout the whole or a greater portion of the year. The other and smaller streams are usually dry, or exist only in the form of a chain of small pools during the summer or dry months.

There are few springs in the county, but water can readily be obtained from wells of medium depth almost anywhere. In nearly every locality the water so obtained is of a very fair quality.

According to the Census bulletin (No. 193,) the number of artesian wells in Robertson county in June, 1890, was 120, showing an average depth for shallow wells of 165 feet, and 750 feet for deep wells, or an average of 464 feet. These wells have an average flow of eleven gallons per minute, and the average cost per well was \$189. Since that time many more wells have been bored in various portions of the county, in all of which water has been found at various depths, although a number require pumping.

The flowing wells are all confined to the southern portion of the area of the Brazos valley as far east as Hearne and Calvert. Wells bored in that portion of the valley lying north of a line drawn from Calvert westward to the Brazos river near Calvert bluff are generally very deep, and in every case require the water to be pumped from 100 to 120 feet.

In the Mesquite prairie region, along the eastern side of the Brazos valley, three wells at Hearne bored to a depth of 520, 700, and 720 feet are all flowing wells. Three wells at Calvert obtained water at an average depth of 600 feet, which may also be considered as flowing wells, although the water in two of them does not rise more than a foot or two



above the surface. The well at the water works obtains its supply at a depth of 587 feet, and provides 135,000 gallons daily. Still farther north, at Bremond, a well said to be 1500 feet deep requires pumping.

In the eastern portion of the county the only well of which any record has been obtained is a 1208-foot bored well at Franklin, from which the water has to be obtained by pumping from a depth of 80 feet.

From all the data at present obtainable there appears to be but slight, if any, chance of artesian water being obtained anywhere outside of the area in the immediate vicinity of the Brazos river and its valley.

## MINERAL SPRINGS.

There are several mineral springs in Robertson county, but those of only two localities are utilized for either commercial purposes or as health or pleasure resorts.

Wooten Wells, the more important of the two, is situated about three miles west of Bremond, with which place it is connected by a short line of railway. There are here four springs, or wells, showing the following analyses:\*

	No. 1.	No. 2.	No. 3.	No. 4.
Chlorine in chlorides.....	24.34	33.13	35.46	36.36
Iron protoxide.....	1.92	.....	.....	.....
Iron sesquioxide.....	0.99	11.08	.....	13.06
Iron oxide.....	.....	.....	} 15.05	} 0.57
Manganese oxide.....	0.54	0.44		
Aluminium oxide.....	.....	.....	.....	.....
Aluminium sesquioxide.....	1.22	1.56	.....	3.46
Soda.....	.....	14.58	.....	18.10
Magnesia.....	13.11	11.38	17.49	22.75
Calcium oxide.....	25.21	25.89	27.10	28.11
Silica.....	3.28	2.82	.....	4.08
Sulphuric acid in sulphates.....	59.67	67.23	79.25	86.41
Volatile and organic matter.....	9.62	.....	12.25	.....
Total.....	139.90	168.11	186.60	212.90

At Franklin the wells known as the Overall mineral wells are used commercially chiefly. The analyses of the two wells located here are:

\* Bulletin No. 32, U. S. Geological Survey. Analysis No. 1 by C. F. Chandler, Nos. 2, 3, and 4 by W. M. Mew.

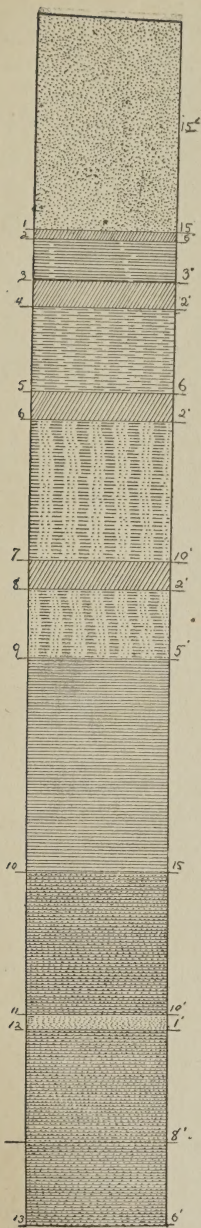
	No. 1.*	No. 2.*
Chloride of sodium.....	9.715	8.053
Sulphate of sodium.....	7.100	41.118
Sulphate of potassium.....	0.752	2.500
Sulphate of alumina.....	1.700	4.898
Sulphate of protoxide of iron.....	75.952	144.903
Sulphate of lime.....	20.965	37.095
Sulphate of magnesia.....	13.063	20.032
Sulphate of ammonia.....	trace	.....
Silica .....	2.041	2.244
Organic and volatile matter .....	2.450	.....
	133.738	260.843
Total grains in U. S. gallon .....		

These waters are acid.

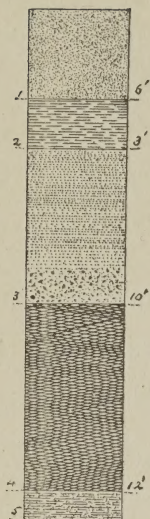
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\* Analyses by Dr. Everhart.

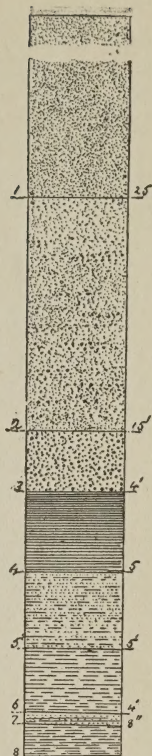




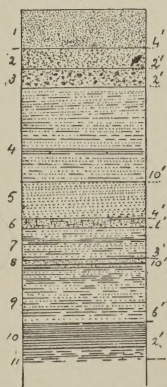
1. MOSELY'S FERRY.  
p. 52.



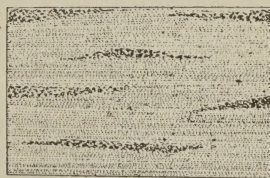
3. BLACK SHOALS.  
p. 56.



2. MOUTH OF  
LITTLE BRAZOS.  
p. 53.



4. OYSTER BLUFF.  
Sec. 1, p. 68.



5. SANDSTONE.  
p. 78.



